Railway Age

MARCH DAILY

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"New Day for Railroad Transportation"

THE optimism felt by Director General of Railroads Davis is indicated by his choice of "The Dawn of a New Day for Railroad Transportation" as the subject of his address last night as well as by the address itself. There seems to be good reason for Mr. Davis' optimism. The policy of regulation embodied in the Transportation Act is highly constructive and in spite of all the attacks that have been made on it this law has now stood the test of five years without any substantial change in its provisions. The railroads suffered severely from government operation but have now almost recovered from its effects, both physically and financially. The percentage of return on the property investment being earned is less than in prosperous years before the war, but with the increase of their capacity, the improvement of their operation and service and the increase that has occurred in their net returns there is more reason for satisfaction with both their present and their prospects than there has been at any time in a decade.

Joint Research by the Railways

PRESIDENT ALFRED of the Pere Marquette, in his very able address last night, pointed out the conservative tendency of individual railways to delay trying improvements in equipment, tools and track accessories until they have been successfully tried by other roads, and favored the establishing of a joint bureau of research supported by all the railroads of the country. As "the first major subject of experiment" he proposed the development of a design for a permanent roadbed. What Mr. Alfred said regarding this matter may well be read and considered carefully by railway executive and engineering officers. The indisposition of most individual roads to incur the expense of making research and trying experiments which, if successful, would benefit all roads, is well known. Progress requires, however, that the cost of research and experiments shall be incurred. Mr. Alfred's advocacy of the establishment of a joint bureau of research, supported by all the railroads, is highly constructive and many very convincing arguments for its adoption can be advanced. The establishment and maintenance of such a bureau would be logically the function of the American Railway Association and it is to be hoped that Mr. Alfred will urge consideration by that organization of the plan suggested by him.

What Is the Purpose of Standards?

THE REPORT of the Committee on Ballast as presented yesterday included among other things a recommendation regarding the withdrawal from the Manual of the standard design for the 15-tine ballast fork. This was recommended because a manufacturer had advised the committee that this design was not

one which could be produced commercially. The interesting part of this recommendation is not that the design was commercially impractical but that the design had been standard for four years without anyone discovering this defect. The only conclusion which can be drawn from the above is that apparently no road was sufficiently interested in a standard ballast fork of this type to attempt to introduce it in actual use. If any road, during the four years which this had been standard, had tried to use the 15-tine fork, it would have been found at once that the design was not practicable. While it is not at all logical to pick out an incident and call it typical, this does illustrate a condition which exists today on the railroads in regard to the use of the engineering standards as adopted by their engineering officers, working as a body in the A. R. E. A. The thoroughness and sincerity of purpose of this Association is recognized in all fields whether related either closely or remotely to that of the railroads. The excellence of the work which has been done by it is also well recognized. In fact, practically the only criticism of any importance that has ever been offered by persons within or without the Association is that the members do not exhibit the same enthusiasm when it comes to the use of standards on their individual roads that they show in the conduct of their committee and association work. There is some measure of truth in this criticism, and in view of this fact the Association could render a real service to itself and to the railroads of the country by making an organized effort to secure an increased use of its standards.

The Colleges and the Railways

A COMMITTEE created by the A. R. E. A. within recent years, the importance of which is not enough appreciated, is that on Co-operative Relations with Universities. Many of the most serious troubles of the railways within the last twenty years have been due to failure to adapt organizations and methods rapidly enough to new conditions. Relations with employes and the public could have been made much better by earlier improvements in personnel and public relations work. Likewise, both public sentiment on the one hand, and the development and management of the railways on the other, could be improved more rapidly by better transportation courses in the universities and by giving college men better opportunities on the railways. Conditions on the railways and in industry in general have changed greatly within the last quarter century. These changes have made far more necessary than ever before men in important positions in industries of all kinds who have not only the practical experience, resourcefulness and energy of the "self-made" man, but also the technical and economic knowledge and the outlook of the broadly educated man. The railways are offering almost no inducements to young men to study transportation matters in college and to enter railway service, while other large industries are offering such inducements, and in consequence in some universities young men actually are being advised to avoid railway service. This policy, which prevails on the railways with a few notable exceptions, is unsound. It may be said that many college men who enter railway service do not "make good." That this is true is partly due to the fact that railways do not co-operate enough with the universities in developing and making their transportation courses valuable. As a matter of fact, however, many college men do make good on the railways, as is proven by the number who start at or near the bottom and advance to high official positions. The man who starts in railroad work without college education, and by hard study and hard work qualifies himself for it, is especially entitled to have the door of opportunity kept wide open for him as it always has been. The main consideration, however, is the welfare of the railroads, which can best be promoted by developing for official positions men of the greatest ability, breadth of vision and public spirit, and in order that this may be done it is quite as essential to give every encouragement and opportunity to the college man as to the non-college man.

Are Railway Structural Engineers Progressive?

MUCH OF THE discussion which took place in connection with the presentation of the Masonry Committee's report centered around a question which has been raised as to the degree of enterprise evinced by railway engineers in keeping abreast with modern developments in the making of good concrete. But as pointed out by Chairman Westfall, current records of the methods pursued by railroads in the conduct of several large railway products show that the engineers of at least some of the railroads have assumed a place of definite leadership in the advance of art and furthermore that among the leading papers presented before the recent convention of the American Concrete Institute were two describing the manner in which the newer methods were applied on railroad work and that the session at which these two papers were read was the best attended.

Before endeavoring to single out the railway engineer as remiss in his concrete work, it would be well to consider whether concrete construction in any other branch of engineering has been marked with equal indications of advancement, not as to isolated instances, but as to the great mass of work being carried on by each branch. It is believed that such an analysis will show distinctly that the railroads are well in the forefront of the proportionate yardage of work being conducted under advanced methods and in point of the relative number of members of the profession who are interesting themselves in th udies of what may be done.

The application of any methods involving the utilization of scientific principles to railroad concrete work imposes a rather serious predicament which arises from the plan of organization under which much of the railroad concrete work is carried on. Except for the larger projects which are normally carried on under contract, railroad work consists of small concrete jobs, many of which do not total more than 300 cu. yd. of concrete, and where this work is done with company forces, it is carried on under the direction of a foreman with such supervision as he receives from the supervisory organization of the bridge and building maintenance force. It is possible to handle the work in this way successfully because of the long experience which these foremen have had in the service of the railroads. While there is admittedly room for improvement in the making of concrete under this form of organization, a change is definitely necessary if the modern methods are to be put into practice, since all those who have described their work in applying scientific methods have stated that the direction of the work is placed under the supervision of men of engineering training. This difficulty is not encountered in the building of larger concrete structures and it is in this that railways will continue to make the most progress in their development work along this line.

Reports that the Rock Island had acquired control of the St. Louis-Southwestern were officially confirmed yesterday.

* * *

W. H. Fechtig, purchasing agent of the Atlantic Coast Line, was among the purchasing officers who were looking over the exhibit yesterday.

* * *

The Interstate Commerce Commission has cancelled its tentative valuation reports on the Gulf, Colorado & Santa Fe and the Grand Canyon & Sunset, both of which have been referred back to the Bureau of Valuation for reconsideration, correction and revision.

* * *

The latest development in train control is an announcement by the Interstate Commerce Commission that it has granted extensions of time under the train control order to the Central Railroad of New Jersey and the Chicago, Milwaukee & St. Paul to July 1.

* * *

H. B. Voorhees, general manager of the Baltimore & Ohio, Western Lines, paid a short visit to the convention and exhibit yesterday. Mr. Voorhees only recently recovered from a serious illness. Colonel Charles Hines, who is doing special work on the B. & O., accompanied Mr. Voorhees.

* * *

Twenty-four officers and members of the American Railway Bridge and Building Association met in the dining room of the Davis store at 12:30 yesterday to formulate plans for the convention of that organization which will be held in Buffalo next October and to receive progress reports from the chairmen of committees.

* * *

Frank W. Edmunds, who has been the secretary of the Signal Appliance Association since its organization 11 years ago, and who has attended every annual convention, is now confined to his home at West Nyack, N. Y., with a serious illness. Mr. Edmunds is the New York manager of the Sunbeam Electric Company and is also president of Craft, Inc. It so happens that Mr. Edmunds is also interested in the Mechanical division of the American Railway Association and is the second oldest living member of that association.

Construction Activities

Late construction reports received from railroads included a statement from the Southern that bids were closed on March 10 for a second story addition to the freight house and passenger station at Somerset, Ky., estimated to cost $48,000. The Louisville & Nashville and the Mobile & Ohio will receive bids on March 18 for a one story passenger station of permanent construction at Humboldt, Tenn. The Chicago, Burlington & Quincy will soon ask bids for a roundhouse at Peoria, Ill., plans for which have just been completed. Plans for passenger terminal imprvements by the Pennsylvania at Pittsburgh have been advanced by the passing of an ordinance by the city, authorizing necessary changes in the streets. Work on this project, which will cost approximately $12,000,000, will be undertaken as soon as the Public Service Commission approves plans and street vacations are effective. The Interstate Commerce Commission has issued a certificate of convenience and necessity authorizing the Waco, Beaumont, Trinity & Sabine to construct an extension from Livingston, Tex., to Beaumont, and also for a belt line at Beaumont. Authority for the construction of certain sections is to be granted only if trackage rights cannot be secured over connecting lines.

The commission has denied authority for an extension from Beaumont to West Port Arthur and for a marine facility line between Port Netches and Port Arthur.

In addition the Southern Pacific has placed an order for 200 50-ton box cars, 200 50-ton tank cars, 200 50-ton single sheath automobile cars and for 1,000 50-ton flat bottom gondola cars, one of the largest orders for equipment for a considerable period.

Signal Section Program

The Signal section of the American Railway Association will open its annual convention at 10 o'clock this morning in the ball room of the Drake Hotel. The meeting will continue through Friday, the sessions extending from 10 a. m. to 12:30 p. m. and from 2 p. m. to 5 p. m. The program for today is as follows:

Chairman's Address.
Committee of Direction.
Committee II—Mechanical Interlocking.
Committee V—Instructions.
Committee X—Signaling Practice.
Committee IV—D. C. Signaling.
Committee VI—Designs.
Committee III—Power Interlocking.
Committee VII—A. C. Signaling.
Committee XI—Chemicals.
Committee IX—Overhead and Underground Lines.
"The Relation of Air Brakes to Train Control," a paper.

An Interesting Decision

A decision has been rendered by the United States District court for the Northern district of Illinois in the case of the Pressed Steel Car Company, complainant-cross-defendant, vs. Enterprise Railway Equipment Company, defendant-cross-complainant, Equity No. 2657, which is of direct interest to those members of the association using dump cars.

The court dismissed for want of equity the Pressed Steel Car Company complaint predicated upon alleged infringement of claims 1, 3, 4, 5 and 6 of Allen letters patent 929,268, also that portion of the Enterprise Railway Equipment Company's counter-claim as predicated upon alleged infringement of claims 78, 109 and 130 of Ingoldsby patent 1,046,191; claim 22 of Ingoldsby patent 1,048,312 and claims 9 and 17 of Ingoldsby and Bowling patent 1,027,851.

As to the Enterprise Railway Equipment Company's complaint predicated upon alleged infringement of claims 86 and 148 of Ingoldsby letters patent 1,046,191, the court held that Frank S. Ingoldsby was the first, sole, true and original inventor and improvements described and particularly recited in claims 86 and 148 of letters patent 1,046,191 and that said patent is good and valid in law as to the said claims; also that the Pressed Steel

Car Company has infringed these claims and upon the exclusive rights of the Enterprise Railway Equipment Company under them. The court ordered that a perpetual injunction should be issued enjoining and restraining the Pressed Steel Car Company, its officers and agents, etc., from directly or indirectly making or causing to be made, using or causing to be used, or vending to others to be used, any articles, devices, apparatus or dump cars embodying or employing inventions and improvements described and claimed in claims 86 and 148 of said letters patent 1,046,191.

Claim 86 relates to cross tying construction commonly used in hopper cars. Claim 148 relates to the use of bulb angles along the top edges of open top gondola and hopper cars.

Tribute Paid Retiring Director Earl Stimson

EARL STIMSON, who retires from the board of direction of the Association at the close of this year's meeting after having served continuously 11 years in that capacity, was paid an unusual tribute at the close of the Wednesday morning session by the presentation to him of a bronze medallion by a group of friends in behalf of the Association, J. L. Campbell acting as spokesman in making the presentation.

The award was made as an expression of "appreciation for this long term of service on behalf of the interests of the Association," and was made pursuant to the adoption of the following resolution:

"That the American Railway Engineering Association in annual meeting assembled, hereby expresses its appreciation and extends its thanks to the retiring senior past president, Earl Stimson, chief engineer maintenance, Baltimore & Ohio, for the conspicuous, invaluable and distinct services rendered during his connection with the board of direction, characterized by wise counsel, good judgment and earnest devotion to the interest and welfare of the American Railway Engineering Association."

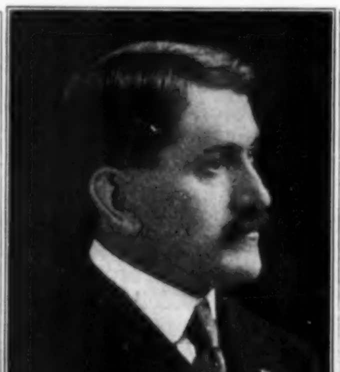
The medallion is a circular brochure wrought of solid bronze, on the face of which is symbolized in relief the figure of Enlightenment drawing aside the veils which hide Ability, with History recording the event in the Book of Time and Industry, preparing to receive the newcomer, while on the back, are symbolized in relief the Laurel Leaves of Honor and the Oak Leaves of Strength joining in an arch above his name which is engraved in the center with appropriate words indicating the nature of the award.

The award is also considered in the nature of a tribute

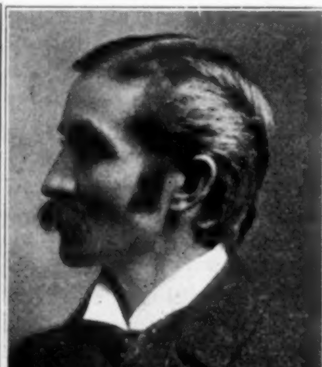
The Two Faces of the Medallion

to the Baltimore & Ohio in view of the early support which this railroad gave the history of the Association, recording the fact that the Association was placed on its feet very largely as a result of the efforts of John F. Wallace, then chief engineer of the Illinois Central, and D. D. Carothers, then chief engineer of the Baltimore & Ohio, who recruited a large portion of the early membership from these two roads.

A. O. Ridgway



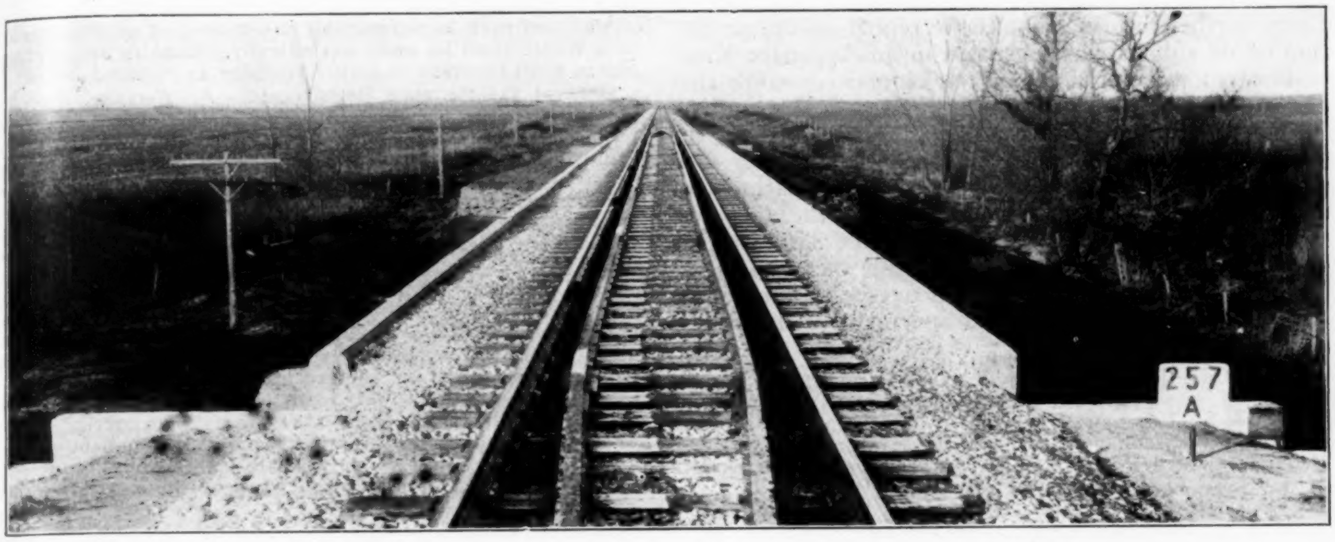
D. J. Brumley



Prof. A. N. Talbot

Col. F. G. Jonah

As They Looked More Than 20 Years Ago



A Concrete Trestle on the Santa Fe

Engineers Have Busy Day at Convention

Both Morning and Afternoon Sessions Were Characterized by Active Interest

THE CONVENTION of the American Railway Engineering Association was called to order promptly at 9 o'clock yesterday morning by President Ray and the consideration of the reports of standing committees was resumed. The Florentine room was well filled throughout the day and those present took a keen interest in the reports. The outstanding features of the day were the active discussion of the report of the Masonry committee, the presentation of a medallion to Earl Stimson on the occasion of his retirement from the board of direction at the conclusion of 11 years' service and a memorial meeting for A. W. Johnston, past president, and H. T. Douglas, Jr., a director of the Association, who died during the year.

Reports were presented by the committees on Electricity, Ballast, Building, Economics of Railway Location, Masonry, Co-operative Relations with Universities, Economies of Railway Operation, and Stresses in Railroad Track.

Report of the Committee on Electricity

The Committee on Electricity submitted a report in which were included a large number of different subjects. Some were in the nature of progress reports on specific subjects and some on relations with other organizations in regard to which final reports are not possible of submission for some time. Included among the progress reports on specific subjects were water power and electrolysis.

E. B. Katte
Chairman

The only material submitted for inclusion in the Manual was a set of revisions of the specifications for the construction of overhead supply lines. As a part of this section of the report but not for inclusion in the Manual were two addendums on transmission lines and the joint use of poles. E. B. Katte has been chairman of this committee for nine years and a member for the past fourteen years.

THE COMMITTEE on Electricity presented reports on 10 different assignments as follows: Progress reports were submitted on inductive co-ordination (Appendix B); water power (Appendix C); electrolysis (Appendix D); co-operation with the Bureau of Standards (Appendix E); collaboration with the Committee on Economics of Railway Location (Appendix G). In an Appendix F the committee presented revisions of the specifications for the construction of overhead electric supply lines, including addendums covering specifications for the maintenance of transmission lines and for the joint use of poles.

Some further information on the report on the protection of oil sidings was presented in an Appendix K.

The recommendations of the committee were that the supply lines specification as revised in Appendix F be adopted for inclusion in the Manual and that the two addendums be tentatively accepted pending final revisions after one year's use, that specifications for tapes be accepted as information, that the specifications for porcelain insulators presented last year be continued as tentative standards and that the tables for clearances for third rail and overhead conductors presented last year be revised and brought up to date next year.

Committee—E. B. Katte (N. Y. C.), chairman; D. J. Brumley (I. C.), vice-chairman; F. Auryansen (L. I.), R. Beeuwkes (C. M. & St. P.), J. C. Davidson (N. & W.), J. V. B. Duer (Penna.), G. Eisenhauer (Erie), *J. L. Harper (Niagara Jct.), R. J. Needham (C. N. R.), Martin Schreiber (Public Service of N. J.), W. M. Vandersluis (I. C.), L. S. Wells (L. I.), L. S. Wells (L. I.), G. I. Wright (I. C.), H. M. Bassett (N. Y. C.), R. D. Coombs (Cons. Engr.), J. H. Davis (B. & O.), W. J. Eck (Sou.), F. D. Hall (B. & M.), W. L. Morse (N. Y. C.), A. E. Owen (C. of N. J.), E. B. Temple (Penna.), H. M. Warren (D. L. & W.), S. Withington (N. Y., N. H. & H.).

Appendix C—Water Power

In this appendix the committee submitted information largely supplemental to its reports on this subject for 1922 and 1923. The points which were covered included the following:

1. The energy derived from water power available for the electrical operation of railroads in and about the city of Buffalo, N. Y.
2. Water power developments on the Clarion River in western Pennsylvania and on other rivers of Pennsylvania, West Virginia and Maryland.
3. Water power developments on the Saguenay River in Canada and on the St. Lawrence River.

Appendix F—Overhead Transmission Lines

The following changes are recommended in the specifications as they now appear:

Section 41—Crossarms: Change the word "crossings" to crossarms.

Section 65 (d): Change the word "lighting" to lightning.

As addendums to the specifications for supply lines, the following specifications were submitted:

SPECIFICATIONS FOR THE MAINTENANCE OF OVERHEAD ELECTRIC SUPPLY LINES

Scope—These instructions and specifications are for the guidance of forces engaged in maintaining overhead electric supply lines for railroad use on railroad property.

Maintenance Forces Shall—Have a clear understanding of the requirements called for by these instructions.

Make themselves thoroughly familiar with the specifications and instructions furnished them. They shall keep such specifications and instructions in good condition and convenient for reference.

Keep informed as to the character and condition of the supply lines and the conditions which may affect their stability and operation, reporting whenever necessary such conditions to the proper official.

Be responsible for the preventable troubles and shall make every effort to reduce the so-called unpreventable troubles.

Be responsible for the proper maintenance of all classes of construction. In case of abnormal conditions due to storms they shall make such light repairs as may be necessary to keep the line in working condition, securing the co-operation of other available forces when practicable. When conditions arise which they are unable to handle themselves, they shall make prompt report to the proper official.

Prevent unauthorized attachments to pole lines and report any foreign attachments in non-standard or unsafe condition.

Report all unsafe conditions at wire crossings.

Report all cases of prospective foreign line construction crossing over or under or paralleling the railroad lines.

Inspections, Examinations, Replacements, Etc. — Lines shall be inspected frequently. Careful examinations of the component parts of supporting structures and of attachments as a whole shall be made periodically. Repairs and replacements shall be made to insure stability as required below.

General Maintenance Requirement—All parts of the supporting structures shall be properly maintained. They shall be strengthened or replaced when the wood poles and crossarms or the guys have deteriorated to 50 per cent of the required initial strength, i. e., to twice the allowable initial unit stress. Structural steel and other metal parts shall be strengthened or replaced when deteriorated to 80 per cent of the required strength, i. e., to 1¼ times the allowable initial unit stress.

Steel Towers—Inspect footings for back fill and condition of concrete if in water. Examine members for straightness, condition of crossarms, nuts, bolts, paint, galvanizing, etc., and correct by means of replacements or otherwise any irregularities that may require attention.

Steel poles, towers or supporting structures, bolts, nuts, washers, anchor rods and similar parts or material subject to corrosion under the prevailing conditions shall be painted as occasion requires. They shall be thoroughly cleaned before painting and no painting shall be done on frosted or wet surfaces.

Pole numbers and danger signs shall be properly maintained.

Wood Poles—Inspect footing for back fill and poles for possible displacements. Examine poles for decay or other imperfections, noting in particular their condition at the ground lines.

Defective poles must be replaced or reset before the depreciation exceeds the allowable limits. When reset they must be placed at the standard depth and the alignment must be preserved. Poles washed out must be reset either in their original location or in adjacent location where conditions are more favorable.

In cases of temporary repairs when it is impracticable to obtain standard depth or setting, permanent repairs must be made at the earliest possible time thereafter.

Leaning poles must be straightened.

Pole numbers and danger signs shall be properly maintained.

Guys—The examination of guys shall include anchors, clamps, guy insulators, guards, etc. The guys or appurtenances must be replaced before the depreciation exceeds the allowable limit.

Slack guys shall be pulled to proper tension. In pulling guys care should be taken not to get the line wire too tight or "Rake" the corner pole too much. Guys at light corners can not be kept tight and must be left with some sag, care being taken to properly clear the line wires. When pulling slack guys watch anchor rod to see if it gives. If anchor rod gives it should be replaced.

Crossarms—Examine carefully for decay and other imperfections. If arms are painted test for dry-rot.

Straighten or tighten crossarms when necessary.

Replacements must be made before the depreciation of any part of the crossarms or fittings exceeds the allowable limit.

Pole Fittings—Inspection and maintenance of hardware and insulators shall include: Tightening of all loose bolts, spreading of cotter keys, replacement of thimbles in joints if missing, inspection of horns for pitting, inspection of insulators for chips or cracks, inspection of pin type insulators for tightness of pins, alignment of pins and tightness of nuts and the correction of any irregularities that may be noted.

Conductors and Ties—Conductors shall be examined for crystallization, pits due to flash over, broken strands, proper condition of shims, abnormal sag, etc.

Ground wire shall be examined for crystallization, broken strands and condition of clamps, bolts, and nuts. Ground leads attached to poles shall be examined for tightness, corrosion at butt and connection to overhead ground wire.

Ties should be examined for tightness. Improper tying introduces weak places in wires. When wires are retied damaged ties should be replaced.

Particular care should be taken in pulling old wire; in general, old wire should not be pulled as tight as new wire except when on the same arm.

When wire begins to give trouble from corrosion it should be carefully inspected and the bad wire removed.

In repairing broken wires the entire span should be examined to guard against kinks and improper sagging.

Clearances and Separations—Specified clearances and separations of conductors of various classes of circuits shall be maintained at railroad crossing and at all other locations.

Trees, Foliage, Brush, Etc.—Trees growing near the line shall be kept trimmed so as to give at least a four-foot clearance from all wires, making due allowance for movement of trees and swinging or increased sagging of conductors.

*Died, November 28, 1924.

Report to proper official any danger-timber that may affect the line.

Fire hazard—the space around poles shall be kept free from underbrush, grass or other inflammable material.

Foliage and Brush—Foliage and vines around the pole and brush under the line shall be removed. Where brush conditions are especially bad report should be made to proper official.

Bird nests should be promptly removed.

Specifications for the Joint Use of Poles for Power, Communication and Signal Circuits

This addendum describes the standard practice for the joint use of electric power, transmission, and distribution circuits, as defined below, with signal and communication circuits on wood pole lines for railroad use, on railroad property. These provisions do not apply to pole lines where Class "E" and Class "C" circuits only are involved.

These provisions are to be used in connection with the foregoing specifications, all the requirements of which, except as modified by this addendum, are to be followed.

Where Class B and D circuits are concerned with communication circuits, joint construction is not recommended but may be used where the right-of-way is restricted and the construction of separate pole lines would result in close clearance to tracks, buildings, etc., and between lines unless the character of the circuits make joint use undesirable.

The circuits involved are classified as follows:

Power, Transmission and Distribution Circuits—Class B constant potential alternating current circuits not exceeding 5,000 volts between conductors (or 2,900 volts to neutral or ground), except circuits described under "E" below. Constant potential, direct current circuits not exceeding 750 volts (except trolley circuits). Constant current series metallic circuits not exceeding 7.5 amperes. This does not apply to lamps operating on current in excess of 7.5 amperes where the line current does not exceed 7.5 amperes.

Class D constant potential, direct current, trolley circuits not exceeding 750 volts to ground.

Class E constant potential circuits, ac, or dc, not exceeding 550 volts between conductors, or 320 volts to neutral or ground, and the transmitted power of which does not exceed 1,600 watts.

Communication and Signal Circuits—Class C communication or signal circuits which operate at not exceeding 400 volts to ground, or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. Below 150 volts, no limit is placed on the capacity of the system.

Relative Position of Different Classes—The relative position on a pole of the line conductors of different classes, when present, shall in general be from the top of the pole downward, as follows:

Class B, Class E, Class D, and Class C. In special cases where Class E circuits are carried below Class C circuits, or on the same crossarms with Class C signal circuits, the following conditions shall be observed:

That such supply line circuits are of insulated wire not smaller than No. 6 AWG copper or its equivalent in strength, and the construction otherwise conforms with the requirements for supply line circuits of the same class.

That the supply line circuits be placed on the adjacent end pins on the bottom crossarm, and that a climbing space of at least 30 in. be maintained up the pole for such wires. Special precautions shall be taken to render such circuits conspicuous, such as painting a stripe on the crossarm or using a different form of insulator from the others on the pole line. That there shall be a vertical clearance of at least two feet between the crossarm carrying these supply circuits and the next crossarm above. That the other pins of the crossarm carrying the supply circuit may be used to carry signal circuits used in the operation of railroad signal systems, such wires to be located in their usual position.

That such supply line circuits shall be equipped with fuses and arresters installed in the supply end of the circuit. The fuses shall have a maximum capacity not in excess of twice the maximum operating current value of the circuit they protect. The arresters shall be designed so as to break down at a voltage of approximately twice the voltage between the wires of the circuit; in no case, however, less than 500 volts. Where the supply line circuits are alternating current, the fuses shall be installed in the secondary side of the supply transformer and designed to operate on a voltage at least as great as that of the primary voltage of the transformer.

Vertical Separation—In order to provide for future growth and at the same time avoid encroachments on the vertical separation, the vertical clearance between Class B primary or series lighting line conductors, and Classes C and D attachments, shall in general be at least 72 in.

In no case, however, except as specified immediately below, shall the vertical separation at the pole between Classes B and C, E and C, C and D, and B and D attachments be less than the values shown below:

Crossarms (center to center)	48 in.
Other attachments (crossarm braces and guys excepted)	40 in.

Where crossarm braces are attached to metal crossarms, or are in contact with transformer cases or hangers, they are subject to the same clearance requirements as the other attachments.

Climbing Space—A clear climbing space at least 30 in. wide between wires and attachments, shall be maintained up the pole. This climbing space may be on one side or corner of the pole only. Where practicable, such climbing space shall be continuous through the wires and attachments of the various classes.

On junction, corner, or other poles where additional crossarms are employed out of parallel with normal crossarms for changing the direction of the line or for branch line, and such construction is below another class, the attachments shall be so located and maintained as to provide and keep open on one side of the pole and next to the pole, as a vertical climbing space or a square of not less than 30 in. on a side. The pole itself and crossarm back braces may be included within the climbing space so measured.

Method of Supporting Line Conductors and Cables—Where cable attachments are made directly to the pole, the full climbing space of 30 in. horizontally shall be maintained for a distance of 48 in. vertically above and below such attachment.

Class B secondary conductors shall not be above, and preferably not on the same crossarm, with Class B primary or series lighting conductors, except on poles carrying only one Class B crossarm, in which case the secondary conductors may be carried on the same arm, but on the opposite side of the pole from the primary or series lighting conductors.

Class B secondary conductors not exceeding 300 volts to ground may be carried on suitable insulators on malleable iron or steel brackets or racks, attached directly to the pole, confined to the Class B space. Clearance from face of pole, specified in section 22 of the specification, shall be observed.

Class C twisted pair distributing wires, or suspension wires carrying Class C cables or distributing wires, may be attached directly to the pole within the Class C space by malleable iron or steel fixture. Where more than eight Class C twisted pair wires are carried along the line they shall be grouped and carried in rings on a suspension strand.

Where a suspension wire carrying any cable is attached directly to the pole and is more than 24 in. below any Class B attachment, and less than 72 in. below the nearest Class B attachment other than cable, a wooden guard-arm shall be attached to the pole immediately above and substantially parallel to such suspension wire.

The guard-arm shall be at least 48 in. in length and shall be securely fastened to the pole by a through-bolt and properly braced. On corner poles, where the cable turns, the guard-arms shall be placed along the climbing side of the pole.

One line conductor may be carried on a suitable bracket attached to the pole at the top by through-bolts.

The use of pole top extension fixtures, except as clearance attachments on joint poles, shall in general be avoided.

Conductors and Cables—Line conductors of Classes B and D circuits shall be of a size not less than No. 6 B. & S. gage copper.

Line conductors of Class C circuits, which occupy a position above line conductors or cables of another class (except Class E), shall be of a size not less than that required for line conductors of similar voltages when placed above Class C circuits.

Class E circuits shall be not smaller than No. 6 A. W. G. copper or its equivalent in strength.

Material other than copper may be used for line conductors, provided the wires of such other material have a strength not less than that of the wires specified above, but no iron or steel line conductors (except lightning protection wires as provided below) shall be used above line conductors or cables of another class except Class E.

Lightning protection wires shall be regarded as supply conductors of the voltage in connection with which they are used in respect to size, material, sag, and strength of attachments, provided, however, that they may be of galvanized stranded iron or steel of a diameter not less than $\frac{3}{16}$ in., ex-

cept in locations where corrosion of iron or steel is unusually severe.

Vertical Conductors—Wires or cables run vertically upon a pole, except above a point not less than 40 in. vertically above the highest Class C attachment, shall comply with the following requirements:

Vertical conductors, except ground wires and Class D feeders in Class D position, shall have an insulation conforming to or equivalent to the requirements of the National Electrical Code for rubber covered wire, for the voltage involved.

Vertical runs of Class B or Class D conductors, except Class D feeders in Class D position, shall be carried taut down the pole by means of insulators on pins or metal brackets and securely maintained at approximately 5 in. from the surface of the pole, and if carried through Class C position shall be enclosed in conduit as specified for metal sheathed cables as in the next paragraph. Multiple conductor cable may be used for vertical runs of two or more Class B conductors of the same circuit. Class D feeders, or taps from Class D feeders, having triple braid weatherproof covering, may be run vertically in the Class D position, provided they are supported on pins and insulators mounted on the face of cross-arms and carried not less than 8 in. from the pole, and are not exposed less than 8 ft. from the ground.

Vertical runs of Class B or Class D metal sheathed cable shall be enclosed within a conduit of suitable insulating material for their entire length, except that, where more than 6 ft. below the lowest Class C attachment (or Class D attachment, if there are Class D attachments on the pole), iron pipe may be used. Such conduit and pipe shall be securely fastened to the pole, and iron pipe shall be permanently and effectively grounded.

Vertical runs of Class C metal sheathed cable which run through wires of another class, shall be enclosed within a conduit of suitable insulating material between points not less than 6 ft. below and 40 in. above such wires. Such conduit shall be securely fastened to the pole.

Twisted pair wires from a Class C terminal box to a Class C arm or bracket may be attached directly to the pole, if within the Class C position.

Ground wires to Class D attachments, and any ground wires which pass through attachments of another class, shall be covered with a suitable protective insulating guard between points not less than 6 ft. below and 40 in. above such attachments. Ground wires shall be suitably insulated and protected from mechanical injury for at least 8 ft. above the ground. Such protective covering shall be securely fastened to the pole.

The same ground wire shall not be used for grounding the attachments of more than one class. Where practicable, ground wires or vertical connections to underground wires of more than one class shall not be attached to the same pole.

Apparatus—Cable boxes, signal boxes, switches, cutouts, and similar apparatus may be installed on the pole at a height convenient for operation, provided:

They do not interfere with climbing the pole.

The requirements as to vertical spacing are observed.

They do not prevent the installation of vertical runs.

They shall, when below attachments of another class, have all live parts protected from accidental contact.

Transformers shall not be located below attachments of a lower class.

Pole Steppings—Poles carrying vertical runs, lamps, transformers, cable boxes, terminals, or other apparatus which may require attention, should be provided with pole steps.

Guy Insulators—One strain insulator shall be placed in every guy at a point between 6 and 8 ft. in horizontal distance from the pole, except that, in short guys, where a point 6 ft. from the pole would be less than 8 ft. above the ground, the strain insulator shall be placed not less than 8 ft. in vertical distance from the ground.

A second strain insulator shall be placed in every guy, except those attached to a wood guy stub at a point more than 8 ft. above the ground. The second strain insulator shall be placed at a point between 6 and 8 ft. from the object to which the farther end of the guy is attached, except that, where this point is less than 8 ft. above the ground, the second strain insulator shall be placed not less than 8 ft. in vertical distance from the ground. In anchor guys the strain insulator shall be placed between 8 and 10 ft. vertically from the ground.

In short guys, in which the two strain insulators here required would be located within 5 ft. of each other, only one strain insulator need be used.

Crossarms—Crossarms, if of selected yellow pine or fir, shall have dimensions not less than the following:

Number of Pins Carried	*Dimensions of Cross-Section*
2 or 4	3 in. by 4 in.
6 or 8	3¼ in. by 4¼ in.

If of other material, crossarms shall be the equivalent in strength and durability of the above.

Discussion

(The report of the Committee was presented by E. B. Katte, chairman, and the recommendations of the committee were accepted by the Association without discussion. The committee was then excused with the thanks of the Association.)

Report of Committee on Ballast

The Committee on Ballast called attention to the fact that the design of the 15-tine ballast fork adopted in 1924 is not one that can be produced commercially and recommended that the design adopted be withdrawn from the manual and that the designing of a suitable fork be given further consideration. It also presented revised specifications for stone ballast with the recommendation that they be substituted for the present specifications in the Manual. It presented as information data on the cost of track maintenance with different kinds of ballast under various conditions, such as traffic, speed, roadbed, climate and cost of production, and proposed specifications for ballasting by contract. F. J. Stimson has been on this committee for 19 years and chairman for the last four.

F. J. Stimson
Chairman

THE COMMITTEE submitted a report, dealing with the (1) Revision of Manual (Appendix A), (2) Revision of the Specifications for Stone Ballast (Appendix B), (3) Cost of track maintenance with different kinds of ballast, considering various conditions such as traffic, speed, roadbed, climate and cost of production (Appendix C), and (4) Ballasting by Contract (Appendix D). The action recommended by the commitee was (1) that the change in the Manual as given in Appendix A be approved; (2) that the revised specifications as given in Appendix B be adopted and substituted in the Manual for the present specifications; (3)

that the matter presented in Appendix C be received as a progress report and the subject in a revised form be continued; and (4) that the matter presented in Appendix D be received as information, and that the matter under the caption "Ballasting by Contract" be withdrawn from the Manual.

Committee: F. J. Stimson, Chairman (Penna.); G. H. Harris, Vice Chairman (M. C.); L. L. Adams (L. & N.), S. A. Jordan (B. & O.), G. J. Bell (A. T. & S. F.), E. Keough (C. P. R.), C. B. Breed (M. I. T.), David McCooe (C. N. R.), C. M. Cannon (S. A. L.), M. J. McDonough (D. & H.), C. J. Coon (N. Y. C.), J. H. Reagan (G. T. R.), C. E. Dare (R. F. & P.), C. K. Scott (Erie), Paul Hamilton (C. C. C. & St. L.), H. C. Smith (Reading), K. Hanger (M.-K.-T.), C. B. Stanton (Carnegie Inst. Tech.), W. S. Hanley (S. & L. S. W.), D. W. Thrower (I. C.), C. B. Hoyt (N. Y. C. & St. L.), L. F. Van Hagen (U. of Wis.), G. D. Hughey (D. & H.), P. H. Winchester (N. Y. C.), H. N. Huntsman (Wabash).

Appendix A—Revision of the Manual

The attention of the committee was called, by the American Fork & Hoe Company, to the fact that the design of the 15-tine ballast fork adopted by the A. R. E. A. in 1921, as recommended standard, is not one which can be produced commercially. When this committee had the subject under consideration and before the design was submitted to the A. R. E. A. with the recommendation that it be adopted as recommended standard, the proposed design was sent to the different manufacturers with the request that they make such comments and criticisms as they desired. No criticisms were received and the conclusion was drawn that from the manufacturers' standpoint the design was acceptable. It now develops that such is not the case.

It is the conclusion of the committee that the design adopted should be withdrawn from the Manual, and that the designing of a suitable fork be taken up by this committee during the ensuing year.

The committee sent a questionnaire to the railroads during the year which developed no sentiment for different sizes of stone for different character of traffic, or any opinion that smaller size ballast would prevent or delay deterioration through dirt collecting in it. Eight roads favored different sizes for different kinds of stone.

In view of the information developed by the questionnaire, the committee decided to make ¾ inch the minimum and 2½ inch the maximum size for ballast.

In considering the matter of physical tests, the committee reached the conclusion that rock meeting the requirements for weight, toughness, soundness, wear and cementing quality will necessarily be satisfactory in strength, absorption and solubility. The last named tests are, therefore, omitted in the proposed specification.

It is obvious that a sample of stone from a given quarry may test better in some qualities and poorer in other qualities than samples taken from a number of other quarries. In order that the tests given in the specifications may be a definite indication of the relative value as ballast of the various samples, some method whereby an equated value may be placed on the result of each test is necessary. The summation of such equated values of the various qualities will be the equated value as ballast (in whatever scale adopted) of the sample and a comparison of such equated values of the samples from various quarries will indicate the relative value as ballast of the stone from the various quarries tested.

Until such a method is evolved the full value of the tests given in the specification cannot be realized. The tests can be used only to check the material to be furnished from a given quarry and will give no measure by which the quarry producing the most valuable stone for ballast may be selected.

A formula for arriving at such an equation has been under consideration by the committee, but sufficient information from which to supply the indices in such a formula are not yet available.

The following revised specification for stone ballast is therefore submitted:

Revision of Specifications for Stone Ballast
Proposed Specification

General

1. Stone for use in the manufacture of ballast shall break into angular fragments which range with fair uniformity between the maximum and minimum size specified herein; it shall test high in weight, toughness, wear and soundness, but low in cementing qualities.

Tests

Tests shall be made as follows:

2. Weight—Not less than one-half cubic foot of solid stone accurately measured and dried for not less than twelve hours in dry air at a temperature of between 125 and 140 deg. Fahr. shall be weighed. The weight shall be not less than .... lb. per cubic foot.

3. Toughness—A piece of solid rock from which a cylindrical core perpendicular to the bedding plane of the rock, 25 m. m. by 25 m. m. (0.98 in. by 0.98 in.) can be cut with a diamond core drill, and the ends ground plane shall, after drying, be held on an anvil, weighing not less than 50 kg. (110.23 lb.) in the Page impact machine, like a miniature pile driver, under a plunger with sphere shaped striking surface of 1 c. m. (0.39 in.) radius, which is struck by a hammer when released weighing 2 kg. (4.4 lb.). The test begins with a 1 c. m. (0.39 in.) fall of the hammer for the first blow, and continues with an increased fall of 1 c. m. for each succeeding blow until the test piece fails, the number of blows and height being the same and representing the toughness of the rock. Rock that shows a toughness of less than .... shall be rejected. (A. S. T. M. D. 3-18.)

4. Soundness—Ten small pieces (total weight about 1,000 grams or 2 lb.) of the rock shall be immersed in a saturated solution at 70 deg. Fahr. of sodium sulphate (Na_2SO_4) for 20 hours, after which they shall be placed for four hours in a drying oven maintained at 100 deg. C. The treatment shall be repeated five times. Rock which exhibits checking, cracking or disintegration shall be rejected.

5. Wear—Five kg. (11 lb.) of freshly broken fragments of stone as nearly alike as possible, shall, after thorough drying, be placed in hollow iron abrasion cylinders, 20 c. m. (7⅞ in.), a 34 c. m. (12.4 in.) in depth in diameter, which are revolved at the rate of 30 revolutions per minute for 10,000 revolutions for each test, after which the pieces shall be thoroughly washed, dried and weighed and the percentage of dust or detritus by weight that will pass through a screen with 1.6 c. m. (1/16 in.) mesh shall be considered the percentage of wear. Rock that has a greater percentage of wear than .... for trap rock, and .... for limestone, shall be rejected. (A. S. T. M. D. 2-08.)

6. Cementing Quality—One-half kg. (1.1 lb.) of stone which can be crushed to pea size, shall be placed (dry) in a ball mill which contains two steel shot weighing 9.07 kg. (20 lb.) each, given 5,000 revolutions at the rate of thirty (30) revolutions per minute, and the dough resulting from a mixture of the dust, screened through a 100 mesh sieve, and water, placed in an air tight vessel for three (3) hours, and then rekneaded, shall be made into six cylindrical briquettes 25 m.m. (0.98 in.) in diameter and 25 m.m. in height and formed under a pressure of 132 kg. per sq. c. m. (1877.5 lb. per sq. in.) after which they shall be allowed to dry 20 hours in air, four hours in a hot air bath at 100 deg. C. (212 Fahr.) and then cooled for twenty minutes in a desiccator, and immediately tested in a machine for ascertaining the crushing strength in pounds per square inch, which is the measure of the cementing value of the rock, the average of five (5) determinations being taken. Rock which has a greater cementing value than .... shall be rejected.

7. Frequency—Tests may be made from time to time at the option of the purchaser, and especially when new strata are being opened up for crushing into ballast.

8. Selection of Samples—Each stratum of a quarry shall be tested separately and not averaged with any other stratum. (A. S. T. M. D. 75-22).

9. Averaging—For obtaining the values for physical tests,

the average results on the numbers of specimens stated in the following table shall be taken:

Kind of Tests	Wt.	Percentage of Wear	Toughness	Cementing Value	Soundness
No. of Tests	5	5	5	5	5

10. Place for Tests—Such tests as are deemed necessary shall be made at a testing laboratory selected by the purchaser, but visual inspection and other tests shall be made at the place of manufacture prior to shipments as often as considered necessary.

Production Requirements

1. Breaking—Stone for ballast shall be broken into fragments which range with fair uniformity between the size which will in any position pass through a two and one-half (2½) inch ring and the size which will not pass through a three-quarter (¾) inch ring.

12. Test for Size—(Maximum). A sample weighing not less than 150 lb. shall be taken from the ballast as loaded in the cars and placed in or on a screen having round holes two and three-quarter (2¾) inches in diameter. If thorough agitation of the screen fails to pass through the screen ninety-five per cent of the fragments, as determined by weight, the output from the plant shall be rejected until the fault has been corrected.

(Minimum). A sample weighing not less than 150 lb. shall be taken from the ballast as loaded in the cars; weighed carefully and placed in or on a suitable screen having round holes three-quarter (¾) inch in diameter. The screen shall then be agitated until all fragments which will pass through the screen have been eliminated. The fragments retained in the screen shall then be weighed and if the weight is less than 95 per cent of the original weight of the sample, the output of the plant shall be rejected until the fault is corrected.

13. Handling—Broken stone for ballasts must be delivered from the screens directly to the cars or to clean bins provided for the storage of the output of the crusher.

Ballast must be loaded into cars which are in good order and tight enough to prevent leaking and waste of material and are clean and free from sand, dirt, rubbish, or any other substance which would foul or damage the ballast material.

14. Cleaning—The ballast shall be free from dirt, loam, dust or rubbish. When the rock is of such a nature that it does not become clean without preliminary scrubbing, a scrubbing machine shall be provided at the quarry.

15. Defect Found After Delivery—As it is impracticable to inspect all the ballast loaded in cars, carloads of defective material at the site for unloading, and not previously inspected, shall be rejected and returned to the manufacturer, who must pay the freight charges both ways. If unloaded prior to discovery of defectiveness, payment without return of the rejected ballast shall be refused to the manufacturer.

16. Inspection—Inspectors representing the purchaser shall have free entry to the work of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the ballast is prepared and loaded in accordance with the specifications and contracts.

In case the inspection develops that the material which has been or is being loaded is not according to specifications, the inspector shall notify the manufacturer to stop further loading and to dispose of all cars under load with defective material.

17. Measurement—Ballast material may be reckoned in cubic yards or by tons, as expedient. Where ballast material is handled in cars, the yardage may be determined by weight, after ascertaining the weight per cubic yard of the particular stone in question by careful measurement and weighing of not less than five cars filled with the material, or the tonnage may be determined for subsequent cars by measurement and converting the yardage into tonnage by the use of the weight per yard as determined above.

Note 1—High quality stone will have the following values:

	Limestone	Trap
Weight per cu. ft.	168	178
Toughness	10	15
Wear	5	3
Cementing Quality	4 lb.	1 lb.

Note 2—Notation under toughness, wear and selection of samples refers to the Standard Methods of the American Society for Testing Materials.

Appendix C—Cost of Track Maintenance with Different Kinds of Ballast

In the assigned subject it is clearly intimated that the results will depend upon many conditions, six of which are specifically set forth. Cost of placing ballast may in fact be affected by many other conditions, such as organization of ballast gangs, partial or complete use of mechanical tampers, types of tampers employed, main line or branch, depth of ballast, weight of rail, spacing of ties, and as many more. The cost of production of ballast alone is a considerable subject.

The sub-committee is unanimously of the opinion that any comprehensive investigation of the subject assigned must of necessity be lengthy and cover more than one year—possibly require three to five years of work of an active committee, coupled with a generous amount of co-operation on the part of the maintenance of way department of the railroads.

Progress in a study of the elements of the subject has been made by former committees and their results have been published in the bulletins. But the subject as a whole has not been comprehensively studied by the Association. It seemed wise, therefore, that the sub-committee devote its attention this year to a study of the way to approach this subject and to separate it, if possible, into subjects sufficiently limited in scope to admit of good results from one year of sub-committee work.

An effort should be made to obtain from various railroads data in as specific form as possible covering their particular problems; no attempt should be made to set up any particular kind of a project and request information upon it, but rather the committee should bend its efforts towards educating railroads in making the necessary observations on any ballasting work that may be undertaken and in recording them. The sub-committee should collect and edit these reports and should itself report certain results from year to year, with perhaps a somewhat comprehensive report in, say, three to five years.

The inherent weakness of cost or time studies is the lack of description so clear and comprehensive that *every* mind familiar with that general type of work will obtain the *same* and *accurate* mental picture of the conditions there prevailing. There are two ways in which this may be accomplished—(a) by long questionnaires; (b) by calling attention to the facts it is desired to observe and leaving it with each road to report upon these facts in its own language. A long questionnaire is discouraging to co-operation and has many other fundamental defects. A long statement of the many facts it is necessary to observe in work is unavoidable. In fact, there are so many conditions to be accurately observed in the simplest case of ballasting, if the results are to be of any value, the committee will be helpless unless the railroads are willing to "go the limit" in the matter of co-operation.

Appendix D—Ballasting by Contract

The committee in its report for 1918 reported adversely on the question of the advisability of ballasting by contract and its conclusion was adopted by the Association and published in the Manual (see page 94, Manual of 1921).

The subject was re-assigned this year and the committee feels, in view of the somewhat widespread interest now being taken in maintenance work by contract, as well as the adoption of this method by some of the railroads with representatives in the Association, that a revision of the Manual, to the extent at least that this method is not discouraged, be made; also that further consideration be given to the preparation of rules for

the guidance of those who desire to undertake the application of ballast in this manner.

The committee at this time has no definite rules to offer, but is submitting as information a typical form of contract and specifications which have been followed with some success by one of the roads, the contract form being drawn up along the lines of the general contract already adopted by the Association, but modified to suit this particular kind of operation, and the specifications being arrived at after about fifteen years of experience as to the best methods of carrying out details of ballasting under traffic.

It is our conclusion that, in view of the widespread interest taken in this subject, the Manual should be changed by eliminating the caption "Ballasting by Contract," and also the subject matter thereunder.

Specifications

Skeletonizing—In skeletonizing tracks the old ballast must be removed to the bottom of the ties uniformly across the entire ballast section, and the material so removed must be deposited on the roadbed shoulders and kept below the level of the bottom of the ties and be leveled off to form a uniform berme outside of the stone ballast line.

Ties and Tie Renewals—All ties must have a bearing against the rail and full spiked with all spikes driven home before tamping.

All ties, including those installed under terms of the contract, shall be spaced during the ballasting operations, so that standard tie spacing at joints and throughout length of rails shall be obtained.

The unit price for tie renewals shall include the necessary trucking of new and old ties, a distance not to exceed 200 ft.

Old ties shall be piled at proper distance from tracks for burning.

Unloading of Stone Ballast—Stone ballast, delivered in Rodger ballast or hopper cars by railroad company's work train, shall be unloaded and distributed by the contractor.

The contractor will pick up and truck surplus stone to points where needed in case of improper distribution.

Lifting—The average lift for each mile will be determined by dividing the sum of the lifts of each station in such mile by the number of stations in a mile; if the average lift so determined falls at eight inches or less than eight inches, the price paid for such mile shall be the price given in the contract for average lift of eight inches; if the average so determined falls between eight inches and ten inches, the contract price for average lift of ten inches will apply; and if the average lift so determined falls between ten and twelve inches, the contract price for average lift of twelve inches will apply; and if the average lift so determined exceeds twelve inches, the price to be applied will be arrived at by multiplying one-twelfth of the contract price for a twelve-inch lift by the actual inches and fractions of an inch lifted.

The lift upon which payments are based is the distance between the top of rail of the track in its original position and the top of the stakes set for top of rail elevation.

All lights in excess of eight inches shall be made in two stages, and an interval of not less than three days shall elapse between each lift and between the last lift and the surfacing lift, and the track shall be so tamped during the timing operations that when surfacing lift is given the track shall be lifted at least one inch and not more than two inches, to bring it to the grade of the stakes.

After all lifts tracks must be maintained by the contractor in proper shape for a speed of thirty (30) miles per hour and after final surface lift must be maintained by the contractor until accepted by the engineer in such condition that trains may run at full speed.

In measuring track lifted, turnouts and cross-overs will be considered as main tracks and contractor shall so regulate his work and forces that at no time will there be over one (1) mile of track uplifted upon which stone has been distributed, nor shall a greater distance than three and one-half (3½) miles be included within the slow boards at any time.

In lifting, all ties that are pulled loose must be replaced in proper position.

Surfacing, Lining and Trimming—Every tie must be well tamped with tamping pick or tamping bar, as directed, from a point 16 inches inside of each rail to the end of the tie, tamping outside of the rails first.

The track must be lined and surfaced to stakes.

Contractor shall trim the ballast to conform to the standard roadbed section and the portion of the sub-grade outside of stone ballast line shall be left in same condition as before any work was done by the contractor.

After the contractor has trimmed the track to the standard section with the available stone and has complied with the above regulation with respect to larrying, he shall load on cars the accumulated surplus in excess of that required for the standard section and shall unload such amount as is required where there is an insufficient amount.

In measuring, lining, surfacing and trimming, turnouts and cross-overs will be considered as main track. No allowance will be made in estimate for work until same has been accepted by the engineer in charge.

Crossings—All crossings must be properly maintained by the contractor while the work being done by him is in progress, and all planking and cattle guards replaced when ballasting through crossings is completed.

Rail Anchors—Rail anchors removed by the contractor or moved during his operations shall be re-applied.

Suggested Contract Form

THIS AGREEMENT, made this first day of April, 192...., by and between ...., party of the first part, hereinafter, called the contractor, and ...., party of the second part, hereinafter called the company.

WITNESSETH, that in consideration of the covenant and agreements hereinafter mentioned to be performed by the parties hereto, and of the payments agreed hereinafter to be made, it is mutually agreed as follows:

The contractor shall furnish all superintendence, labor, transportation and camp supplies, except as hereinafter specified and shall execute, construct and finish in an expeditious, substantial and workmanlike manner, to the satisfaction and acceptance of the chief engineer of the company, the stone ballasting of .... single track miles, more or less, of the company in the United States, in accordance with specifications attached, identified by the signatures of the parties hereto, and the following general conditions and requirements forming part of this contract:

The work covered by this contract shall be commenced by the contractor within ten days after being notified by the company that work is to proceed.

And in consideration of the completion of the work described herein and the fulfillment of all stipulations of this agreement to the satisfaction and acceptance of the chief engineer of the company, the said company shall pay or cause to be paid to said contractor amount due to the contractor based on the following prices:

$................ per mile of track skeletonized in gravel.
$................ per mile of track stone ballasted with average lift of twelve (12) inches.
$................ per mile of track stone ballasted with average lift of ten (10) inches.
$................ per mile of track stone ballasted with average lift of eight (8) inches.
$................ per tie installed.
$................ per mile additional for each mile of track stone ballasted under new rail not spaced.

It is mutually agreed that the unit prices hereinbefore set forth are based on a common labor rate of .... cents per hour and that such unit prices shall be increased or decreased from time to time in the same ratio as the rate paid by the contractor to common labor bears to the basic rate of .... cents per hour. Variations in rate of pay to common labor not to be put into effect in the absence of written consent of the chief engineer.

[Note—General conditions forming a part of this agreement have been omitted.—EDITOR.]

Discussion

(The report was submitted by F. J. Stimson, chairman, who *moved that the design for ballast forks be withdrawn from the Manual and that the designing of a suitable fork be taken up by the committee during the ensuing year. The motion was carried.* Paul Hamilton, chairman of the sub-committee, presented the report in Appendix B, on specifications for stone ballast and *moved that they be substituted in the Manual for the present specifications.*)

C. W. Baldridge (A. T. & S. F.): I have one objection to the form of the specification in the matter of dimensions, weights, etc., being given first in the metric system followed by the standards of this country. Fully

97 per cent of the membership of this Association belong in this country or in British possessions. Of the remaining members, practically half of them originally belonged in the same countries. If it is desirable to have the equivalents of the metric system shown, they should follow the dimensions given in our own system of weights and measures.

Chairman Stimson: These specifications for tests are taken direct from the A. S. T. M. reports, and they are given in the metric system. The position taken by Mr. Baldridge that this Association is using the ordinary English system of weights and measures is correct and it is proper for them to appear first in the report.

W. H. Kirkbride: In connection with the questionnaire sent out, relative to size, ¾ in. is used as a minimum and 2½ in. as a maximum. The specifications also call for stone that will pass a 2½-in. ring and a ¾-in. ring. My observation has been that the rock is slightly smaller than the size of the ring. For instance, a 2½-in. ring will produce 2¼-in. rock; a ¾-in. ring will produce ½-in. rock. It ought to be made plain as to whether we are going to use specifications referring to the size of the ring or the size of the rock.

Mr. Hamilton: The specification is that stone shall be broken in sizes which will in any position pass through a 2½-in. ring and a size which will not pass through a ¾-in. ring. This specification leaves it to the manufacturer to arrange his screens so that the final product will be of these sizes.

Chairman Stimson: The matter is fully covered under "Proposed Specification, Test for Size," in which it provides that the sample shall be placed on a screen having round holes 2¾ in. in diam., it being thought that 2¾-in. hole in the actual screen operations will give a 2½-in. stone.

(Motion carried.)

(The committee was dismissed with the thanks of the Association.)

Report of the Committee on Masonry

The report of the Committee on Masonry on the principles of design of concrete, plain and reinforced, for use in railway structures, rounded out the progress report of last year on the same subject and was submitted with the recommendation that the conclusions be approved for publication in the Manual. It called attention to the complete lack of specific and reliable information as to embankment pressures on culverts under deep fills and in consequence limited its studies to the vertical loads encountered. It also presented rules for the inspection of masonry structures. The committee called attention to the report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. This is C. C. Westfall's third year as chairman of the committee and his sixth as a member.

C. C. Westfall
Chairman

THE COMMITTEE presented a report covering (1) the principles of design of concrete, plain and reinforced, for use in railroad structures (Appendix A), and (2) rules for inspection of masonry structures (Appendix B). The action recommended was that the conclusion in Appendix A, relating to principles of design of concrete, plain and reinforced, for use in railroad structures, and the rules for inspection of masonry structures, contained in Appendix B, be approved for publication in the Manual.

Committee—C. C. Westfall (I. C.), Chairman; T. L. D. Hadwen (C. M. & St. P.), Vice-Chairman; J. T. Andrews (B. & O.), R. Armour (C. N. R.), P. T. Barrett (C. & W. I.), G. E. Boyd (Railway Review), H. M. Brown (F. E. C.), T. L. Condron (Con. Engr.), L. H. Hornsby (S. A. L.), C. P. Howes (T. & P.), Paul Kirscher, W. S. Lacher (*Railway Age*), A. N. Laird (G. T.), J. A. Lahmer (M. P.), H. C. Libby (Sou.), C. P. Richardson (C. R. I. & P.), F. E. Schall (L. V.), L. W. Skov (C. B. & Q.), A. W. Smith (C. N. R.), Job Tuthill (P. M.), J. J. Yates (C. R. R. of N. J.)

Appendix A—External Loadings on Track Structures

Last year the committee presented a progress report on this subject. The committee has reviewed the work of last year in the light of the discussion presented at the convention and has also studied such other material as could be obtained, including the replies received to a questionnaire issued for the purpose of ascertaining present practice. These replies disclosed a wide diversity of opinion concerning the loads for which culverts should be designed, a condition which may well be ascribed to the lack of specific test data on which to base definite assumptions.

The committee knows of no investigation of embankment pressures except for such shallow depths as are covered by the work of the Joint Committee on Stresses in Track. The conclusions it presents are therefore based primarily on a review of current practice and the analysis presented below.

The vertical pressure encountered in an embankment may be considered under three heads—dead load, live load and impact, which are discussed in turn below.

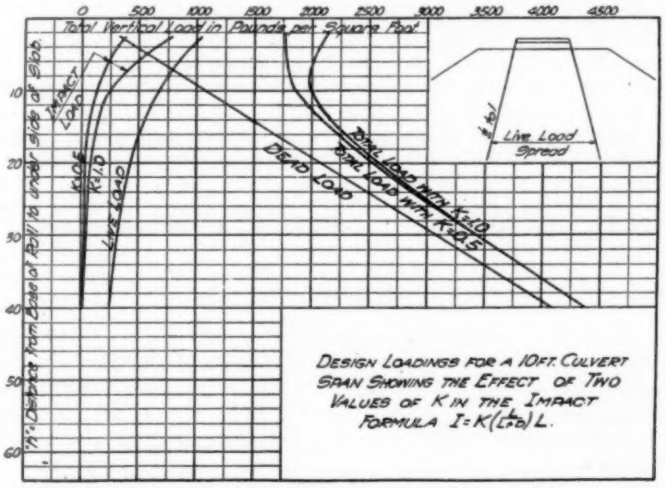
Dead Load

The assumption of a unit weight, 100 lb. per cu. ft. for the material in earth embankments is one of long standing, and the use of this round figure seems consistent with the other approximations which lack of specific knowledge demands. The adoption of a greater unit weight is, of course, necessary for fills of obviously more than normal weight. A few roads make special provision for lean iron ore or other heavy materials by unit weights of as much as 150 lb.

For what depth of fill shall the full load be assumed

as coming on the culvert? The assumption that a culvert must be designed to carry the full weight of a fill in the prism of material vertically above the base area regardless of the depth of the fill, is subject to considerable dispute. Some designers assume that "arch action" relieves the culverts of a part of the weight of fill above it. Tests at Iowa State College, on the other hand, indicate that loads, in some cases at least, in excess of those represented by the superimposed prism will be encountered.

It is clear that the weight of a fill must be carried by the foundation on which it rests, whether this is composed entirely of the original ground surface or consists in part of a culvert. It is equally obvious that as long as foundation conditions are uniform, so that equal settlement occurs under all parts of the fill having the same depth, the loads carried by all parts of the bearing area would be substantially the same. Conversely, one part of the bearing area under



How Variation in Assumptions as to Impact Influences The Determination of the Design Load

the fill could be made to carry more or less of the weight of the embankment directly above than that represented by the superimposed prism, only as it settles less or more than the ground surface on each side of it. In the case of a rigid structure, such as a masonry culvert, there are few conditions which could bring about a greater relative settlement of the culvert. Consequently, it would seem that under usual conditions the culvert must carry loads equal to or greater than that of the prism of fill directly over it and that it is, therefore, the better part of reason to recommend design dead loads which include the weight of the entire superimposed prism of fill.

Live Load

The effect of the live load is commonly obtained by assuming that it is distributed uniformly between two spread planes extending downward from the ends of the ties, but this assumption is subject to considerable variation with respect to the slope at which the "spread" takes place. According to the replies to the questionnaire, practice ranges from a slope of ¼ to 1 to a slope of 1½ to 1. The committee advocates a slope of ½ to 1, but calls attention to the fact that this assumption presumes the spread of the actual live load influence over a greater area than that which falls within the limits of the two ½ to 1 spread planes. The actual influence of the live load on any horizontal plane must necessarily be greatest under the center line of the track and gradually taper to zero at some distance on either side. Therefore, to obtain a unit value for the intensity of the live load pressure approximating the actual maximum pressure on any given horizontal plane by dividing the load per foot of track by the distance between the spread planes, it is necessary that these arbitrary spread planes fall considerably inside the probable limits of the actual live load influence.

Concrete slabs with shallow fills or nominal depths of ballast require special consideration because of the less complete distribution of the live load through the agency of the rails, ties and ballast. Reports of the Committee on Stresses in Track show that a substantially uniform longitudinal distribution of the live load is effected at a depth of approximately three feet below the base of rail, but that for depths of fill less than three feet the extent of the distribution is subject to considerable variation. It would appear, therefore, that the live load on slabs with depths of fill of less than three feet below the base of rail should be assumed as concentrated wheel loads.

Impact

In so far as the committee has been able to ascertain, no data are available as to the quantitative effect of live load impact on a railway embankment to sufficient depths to be applicable to general culvert design. Obviously this effect decreases with an increase in the depth of fill or an increase of the ratio of dead load and live load. For this reason culvert designers have in most cases applied arbitrary reduction factors to the impact load, to compensate for increases in the depth of fill, but present practice is exceedingly varied. Obviously, impact formulas such as those used in specifications for steel bridges in which the independent variable is the span length, are not applicable to culvert conditions since such formula takes no account of the effect of the variation in the depth of the fill or the ratio of the dead load to the live load.

It is believed, therefore, that a closer approximation of the truth would be obtained by a formula in which the independent function is represented by some relation of the dead load to the live load. Two such formulas have been suggested:

$$I' = \left\{\frac{L - KD}{L}\right\} \qquad I' = K\left\{\frac{L}{L+D}\right\}$$

Where I' = percentage factor to be applied to the live load to obtain the impact load I.
K = some unknown co-efficient.

The second formula would seem to meet more nearly the qualitative requirements. However, absence of specific test data makes it impossible to assign a specific value to the co-efficient K. The formula is used by a number of railroads with values for K ranging from 1.0 to 0.5.

While use of the two values of K result in widely differing values of the percentage impact, I', this disparity becomes less apparent when all three factors of the load, namely, dead load, live load and impact load, are combined as total load. This is illustrated in the chart showing the effect of two values of K, namely, 1.0 and 0.5, in determining the design load for a 10-ft. span with various depths of fill.

As stated above, there are no data upon which to base any definite recommendations for the value of K to be used in the impact formula. Until specific information is available it would seem that the use of the co-efficient 1.0 would represent conservative practice.

Conclusions

Dead Load—(1) The dead load should be assumed as the weight of the track, ballast, fill and culvert masonry em-

braced within the vertical prism above the portion of the structure under investigation.

Live Load—(2) The live load on structures buried to a depth of three feet or more below the base of rail shall be assumed as distributed uniformly in a longitudinal direction. Except as modified in paragraph 3, it is further assumed to spread transversely so as to give a uniform distribution of pressure on all horizontal planes lying between two planes inclined at outward slopes of ½ to 1, these planes being fixed by lines drawn through the ends of the ties at the base of rail.

(3) The spread of the live load shall be assumed at not less than 13 feet unless slabs under relatively limited depths of fill are divided by longitudinal joints into units of such width that some possible location of the track or tracks will result in a concentration of the live load on the slab or slabs, that would necessarily exceed that indicated by the above assumption. Such cases must be analyzed individually.

(4) The live load for a depth of fill of less than three feet below the base of rail shall be assumed as concentrated wheel loads.

Impact Load—(5) The impact load shall be derived from the formula:

$$I = K\left[\frac{L}{L+D}\right]L$$

where I = the impact load
D = the dead load as derived according to Paragraph 1.
L = the live load as derived according to Paragraphs 2, 3 and 4.
K = a co-efficient.

No specific value for K is recommended but it is suggested that a value of 1.0 represents conservative practice.

Appendix B—Rules for Inspection of Masonry Structures

Inspection of structures of stone or concrete masonry shall be made by men experienced with this class of construction.

The report shall be prepared in such form and in such detail, including sketches or photographs if necessary, as to afford an exact idea as to the condition of the structure and the necessity and extent of any repairs which may be required.

The report shall give the name of the division, bridge number and name of the stream, street or other crossing, followed by a brief description of the kind of bridge and the type of construction. This shall be followed by the characterization of the condition of the masonry in the opinion of the inspector, based upon the points brought out in the instructions which follow; this characterization to be explained by the words "Very Good," "Good," "Fair" or "Poor." It will, in general, be unnecessary to give further detailed description of the condition of structures classified as "Very Good" and "Good."

In the case of a structure where the conditions are so unsatisfactory as to justify its being classified as being "Fair" or "Poor," a sufficiently detailed description shall be given based upon the rules that follow, to justify this classification.

The inspector shall first examine the structure for any indication of settlement or other movement. This may be shown by inequalities in the line or surface of the track or by improper space between the back walls and the ends of the supported superstructure.

He shall watch the structure under passage of trains to see whether there is any movement in any joints or courses of masonry or any tipping or working of the structure as a whole.

The pedestals and bridge seats shall be examined for indications of crushing or settlement or other movement.

Expansion joints and bearings shall be examined to see that the movement is not restricted.

Investigation shall be made for signs of undue weathering, disintegration, cracks, crushing, leakage, bulging or need of pointing.

A careful inspection shall be made at the water or ground line for disintegration due to the action of water or ice.

The inspection of foundations shall include an examination for indications of scouring or undermining and when necessary, soundings shall be taken for this purpose.

In connection with the inspection of arches and culverts, sufficient examination shall be made to indicate the need for additional protection in the form of paving, inverts, apron walls or curtain walls.

If definite and reliable records are not available, a field examination shall be made to determine the type and physical condition of the foundation.

Soundings shall be taken to determine the relative elevation of the bed of stream and the bottom of the masonry.

Attention shall be given to any signs of failure of arch rings as may be indicated by cracks or a flattening of the arch.

Reinforced concrete structures shall be examined for any indications of leakage or softening of the concrete. Any instances in which the reinforcement is exposed or rust stains appear, shall be reported.

The provisions for drainage shall be examined to see if they function properly.

General

The inspector shall, so far as possible, obtain the history of any defects in order to determine, if possible, the exact cause.

In calling attention to defects, mention shall be made as to whether these have the appearance of recent development or whether they seem to be of long standing. The inspector shall compare conditions with those recorded from previous inspections and report any change.

In reporting cracks in masonry, the inspector shall state whether they have the appearance of surface checks or cracks which would indicate incipient failure. In the latter case, permanent marks shall be made on either side of the cracks and measurements taken so that developments can be accurately determined.

When signs of settlement or movement are noted, lines and levels shall be run and reference marks established so that subsequent movement can be determined.

In general, inspections shall be so exact and the report so carefully prepared that it will afford a permanent record of the exact condition of the structure.

Discussion

[The report was presented by C. C. Westfall, its chairman, in Appendix A, on the principles of design of concrete, plain and reinforced, for use in railroad structures being submitted by W. S. Lacher, chairman of the sub-committee, who *moved the adoption of the conclusions.*]

R. A. Baldwin (C. N. R.): The clause which deals with dead loads makes it appear that the conclusion has been based on the tests of the Iowa State College. It would be interesting to have the details of how the tests were made.

W. S. Lacher (*Railway Age*): The tests at the Iowa State College were considered in connection with the study of the sub-committee, but it was considered that, as carried thus far, they were not distinctly applicable to the work which was covered in this report. The committee definitely excludes consideration of pipe culverts, because that subject has been assigned to a special committee and the work that was done at Iowa State College has been restricted to the pipe culverts. As stated under the discussion of dead load, the loads in many cases are in excess of those represented by the prism of earth directly over the structure. The committee felt that it was sufficiently conservative to base the dead load on the vertical prism.

(Motion carried.)

Chairman Westfall: An editorial in a general engineering journal appeared recently that constituted an indictment of railroad engineering in general and railroad concrete work and structural engineering in particular. It would seem that the thought behind that editorial is the so-called development in the art of concrete work, having to do with proportioning mixtures! The statement would seem to indicate that the railroads are following the rest of the profession. This Association has had a membership on the joint committee which has sponsored the recent developments in the art of making concrete. Four railroads have applied theories to very

large projects, and in addition some four or five other railroads have studied the proposition extensively with the idea of making use of these recent ideas. The American Concrete Institute held its convention in Chicago within the past three or four weeks, and two of the leading papers at this convention were papers by railroad men on railroad work, and one entire session of the convention was devoted to railroad work. *This would all seem to indicate that the railroads, instead of trailing the procession, are at least up with the leaders and possibly leading them a little bit.* Along this line, Mr. Richardson of the Rock Island has been chairman of the sub-committee which has studied this subject, and Mr. Richardson will make a few remarks on the subject.

C. P. Richardson (C. R. I. & P.): It has developed during the past year that the railroads are really pioneering in this work. The sub-commitee assigned to the subject of "Developing the Art of Making Concrete" is fully in touch with all of this work. We have among the members of this association engineers who have put in many days and weeks of their personal time making a study of these modernized methods. I believe the problem before us today is to simplify and place these principles before the average engineer in a manner so he can quickly assimilate and utilize them as far as practical on his particular job, the more important control methods developed by these studies.

R. H. Ford (C. R. I. & P.): I am wondering whether the committee has thought of the desirability of following up the results more as to the failures. We really can learn a lot of things from the failure of pieces of construction.

Chairman Westfall: The committee had a subject assigned about two years ago on concrete failures and there was such a hesitancy on the part of railroad engineers to acknowledge they had failures that we toned the subject down and left out the word "failure."

Mr. Lacher: While it is very easy to go out and find work that is obviously defective, the citing of that or any other case as defective is not of particular value unless the history of that work is determined. Unless one is able to find out what caused that defective work, no particularly valuable conclusions can be drawn.

Chairman Westfall: The committee at this time wishes to present the report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. Mr. Yates, who was chairman of the representation of this Association on the committee, will present this report.

J. J. Yates (C. R. R. of N. J.): In presenting this report I want to say that the sub-committee of the joint committee have not all passed on it and a few reservations have been made. However, in presenting this report it is not for adoption at this time as we desire to consider it very thoroughly the coming year and we are asking for a discussion.

[Mr. Yates then described in detail the manner in which concrete construction is carried out in building the sub-structure of the Newark Bay bridge of the Central of New Jersey involving the mixing and placing of 140,000 cu. yds. of concrete. In this manner he illustrated in a practical way the procedure followed in applying scientifically prepared concrete and the high uniformity of results obtained in applying scientifically prepared concrete and the high uniformity of results obtained in the quality of the product.]

B. R. Leffler (N. Y. C.): I wish to call attention to one feature of the principle, of the fineness modulus. It seems to me it has not yet been proven with any laboratory experiments that the fineness modulus is an index of the density of the concrete. It is true that sand that is properly graded so as to give the maximum density in the mortar, with the least amount of water, will give mortar of great strength, but the converse has not been proved, namely, that sand with any suitable fineness modulus gives the greatest density.

J. B. Hunley (C. C. C. & St. L.): Mr. Leffller, I think, is quite right. The fineness modulus does not determine the density, as far as we have been able to find out, and I think one of the most important things in making concrete is the character of your sand. I am heartily in sympathy with proportioning concrete on a strength basis. The Big Four has been doing that for three years, not only on large jobs but on small jobs of a hundred yards or so. I am afraid if the tables in the appendix of the report go out as they stand, that many who attempt to use them will get disgusted. The difficulty is that the slump does not determine the water cement ratio except for one aggregate. I am in hopes that the specification will be developed based on proportioning on the strength basis. It can be done.

Prof. A. N. Talbot (Univ. of Ill.): I would like to make some comment on the tables of proportions which are included as the appendix. From what I knew of the proportioning of concrete, it seemed to me that this would not give very uniform results, and, accordingly, running over the last three years, we made three sets of tests covering about the same ground.

[Prof. Talbot described these tests in some detail and outlined the results, which showed that the proportions and consistencies which should have given uniform results, according to the tables, disclosed widely varying strengths in the tests.]

Dr. W. K. Hatt (Purdue Univ.): My understanding of these figures is that they are very conservative. In a normal case the value resulting in strength in these slumps would be perhaps 50 per cent or 30 per cent higher than the value quoted. They are conservative, and it seems to me that is a better condition than if they were exactly right.

A. C. Irwin (Portland Cement Asso.): I think it would be a good idea to get a better notion about how these tables came about and why they are still in the joint committee's report. They are not put in this report in any other way than as an appendix. The joint committee has not put its "O. K." on the accuracy of these tables under all conditions. It has written certain limiting conditions as an introduction to the tables, which if carefully considered will take care of a certain amount of the criticism that has been aimed at them.

Vice-President Fairbairn: I think before we go any further I might perhaps read the preamble to this report, because it seems to me that that more or less clarifies the situation. (Mr. Fairbairn then read the preamble to the report of the Masonry Committee.) In other words, the committee is simply asking for discussion at this time and wanting the report put in the bulletin simply as something to draw discussion and give them help before they formulate their final report for which they will ask adoption.

F. F. Harrington (Virginian): I just want to say that the tests that are now being made will demonstrate whether the conditions given in this report are correct. The report is subject to correction, pending the result of these investigations, and I think when they are completed it will throw further light on the subject.

(The Committee was dismissed with the thanks of the Association.)

Report on Economics of Railway Location

The Committee on Economics of Railway Location, in line with its past work of studying the fundamental principles of this subject, presented a progress report on the methods of estimating speed, time and fuel consumption, either for lines to be constructed or for revisions of existing lines. The report discussed the different factors affecting these investigations and called attention to the importance of differentiating speed as between that based on running time between stops and elapsed time between terminals. An outline of the computations for the speed-curve method was given, together with a modification of this method, especially adapted to computing the values of rise and fall. E. E. King, who is completing his second year as chairman of the committee, has been a member of it for 3 years.

E. E. King
Chairman

THE COMMITTEE presented a report covering methods of estimating speed, time and fuel consumption (Appendix A), and recommended that the material in Appendix A be accepted as a progress report.

Committe: E. E. King (U. of Ill.), Chairman; H. C. Searls (M. P.), Vice-Chairman; John C. Beye (I. C. C.), Edward C. Schmidt (U. of Ill.), A. S. Cutler (U. of Minn.), A. K. Shurtleff (A. R. E. A.), A. S. Going (C. N. R.), C. W. Stark (U. S. Chamber of Com.), C. P. Howard (I. C. C.), P. E. Thian (N. P.), Frank Lee (C. P. R.), A. M. VanAuken (Con. Engr.), Fred Lavis (Con. Engr.), R. H. Washburn (C. & A.), F. R. Layng (B. & L. E.), Walter Loring Webb (Con. Engr.), E. W. Metcalf (M.-K.-T.), M. A. Zook (M. W. & S.).

Appendix A—Methods of Estimating Speed, Time and Fuel Consumption

The investigation is necessarily variable, depending on whether (a) the section of road to be investigated is not yet constructed and it is desired to estimate the performance of a certain proposed type of locomotive handling an estimated volume and kind of traffic, or (b) it is desired to estimate the value of certain proposed improvements to an existing line, on which tests of present performances can be made. It should be realized that no definite and exact rules can be formulated to fit all cases for computing speed and time, since the speed, or rather the time required to get heavy traffic over the road or division depends on a great multiplicity of conditions, many of which are being more or less changed either temporarily or permanently. These conditions, and the effects of changes in them, are listed below.

(A) Roadbed

(1) *Profile.*

(2) *Curvature.*

(3) *Grade Intersections*—The line followed by the center of gravity of the train will not be parallel vertically with the track profile at grade intersections. Thus, when the center of a sixty-car train reaches a grade summit the engine and caboose may each be several feet lower, depending on rates of grade, length of vertical curve, length of train, etc.—the center of gravity of the train being lifted two or three feet less than indicated by profile.

(4) *Stops.*

(5) *Location of Sidings.*

(6) *The Condition of Track and Roadbed.*

(7) *Coaling and Water Stations.*

(8) *Number of Tracks Available.*

(B) Congestion

The number of trains and congestion of traffic have no effect on the theoretical speed between stops. Yet practically it may have an important effect, for on a busy track one heavily-loaded slow-moving train may set the pace for several trains behind it.

(C) Delays

Running time plus delays make up elapsed time. Elapsed time is the thing that counts and is the basis of payment for overtime.

(D) Tractive Force

It is necessary to know or compute the tractive force of the locomotive at varying speeds, from which a curve may be plotted. In the absence of actual tests it may be calculated from the data on pages 805 to 813 of the Manual. To use these data every essential characteristic of the locomotive must be known or assumed as well as the heating value of the coal.

(E) Tonnage, Number of Trains, Stops, Etc.

For a given engine and train the estimated speed between stops can be calculated and platted as a curve on the profile and from this the running time may be computed. Traffic in each direction should be considered separately as the tonnage, grades, stops and composition and weight of trains are frequently so different as to constitute entirely different problems, requiring separate calculations as to speed, time and fuel consumption.

Outline of Computations

1. Consider traffic in each direction separately.

2. Calculate the drawbar pull of the locomotive on a level tangent at various speeds from zero speed to the maximum speed allowable, using the method and tables shown on pages 805 to 813 of the Manual. Four thousand pounds of coal per hour may be assumed as the rate of consumption for the engine when working on the basis of hand firing. A greater rate may be maintained for short periods and probably less at other periods. It is believed, however, that the assumption of the uniform rate of 4,000 lb. per hour with the modification noted in Paragraph 7 below for light descending grades will give satisfactory results.

If the locomotives are equipped with stokers with an average rate of consumption of 6,000 or even 8,000 lb.

of coal per hour when working, the table of drawbar pull may be computed accordingly.

The thermal value of the coal must be known or assumed and may be taken at about 90 per cent of the thermal units (B.t.u.) of air-dried mine samples.

3. The frictional resistance of the train may be calculated from page 815 of the Manual, the number of cars and gross weight of train being known or assumed.

A considerable number of trains may leave the terminal short or with engines not loaded to rated capacity, but calculations as to speed and time should probably be made in most cases on the basis of fully-loaded engines. These may govern the speed of lighter trains following, which otherwise might make better time.

4. Grade and curve resistance in pounds, minus or plus, may be computed for any point on the profile and is equal to twenty times the gross weight of engine and train in tons times the per cent of grade; the actual grade having been increased about 0.04 per cent for each degree of curve, if an ascending or level grade, and similarly decreased if descending.

5. The algebraic sum of drawbar pull on level tangent, frictional resistance of train and grade and curve resistance for gross weight of engine and train, gives the force which is available for acceleration, or which will produce retardation if it is negative.

6. Acceleration and retardation tables should be computed and curves may be platted for various grades ascending and descending for the given locomotive and train. The formula (Manual, page 804) may be stated:

$$s=\frac{70\,(V_2^2-V_1^2)}{P}$$

Where P =accelerating or retarding force in pounds per ton of gross weight of engine and train.
V_1=a given velocity.
V_2=the velocity to which it is to be accelerated or retarded.
s =distance in feet to accelerate or retard from V_1 to V_2 speed.

Acceleration curves may be computed for velocity increments of one mile per hour from zero speed to the highest attainable or allowable speed; retardation curves decreasing by similar increments from the maximum allowable to the maximum speed which may be maintained on the given grade.

7. Plat the speed line on the profile, assuming as a sufficiently close approximation that the engine is either working and exerting its full tractive power at the given speed and rate of fuel consumption or is drifting. On light descending grades or elsewhere when the full tractive power is not required to maintain the desired speed the engine may be considered as alternately working and drifting for small increments of time, the proportion of time working being the algebraic sum of frictional and grade resistances divided by the available drawbar pull.

8. Estimate the time by multiplying the distance in stations by the time (n) in decimals of a minute required to travel one station at the given speed. This can be measured by a scale showing values of (n) for corresponding speeds. Where the speed varies appreciably time should be taken for separate intervals of distance, 10 stations, 5 stations, or less, as in such case distance multiplied by the value of (n) for the average speed does not give correct time.

9. Multiply the total time of engine working and drifting by the corresponding rates of fuel consumption. The rate of fuel consumption for engine drifting may be estimated from the table on page 6 of the paper by A. K. Shurtleff in Part 2, Vol. 14, American Railway Engineering Association, 1913. Fuel for engine firing up per trip and rate of fuel consumption per hour for engine standing may be estimated from the same table.

General Remarks

The method above outlined is known as the "Speed-Curve" method. For coal-burning locomotives, tables 1 to 7, pages 807-813 of the Manual, may be utilized. The general method, however, applies to any kind of power, steam or electric. It consists essentially in operating the train on paper. Tables once constructed for a given locomotive, train and grades can readily be expanded and modified to cover any combination of train loading and grades.

Conclusions

Speed and Fuel Consumption

Speed should be differentiated as between speed based on running time between stops and speed based on elapsed time between terminals.

Elapsed time is the sum of delays, plus running time. Time lost in delays varies with congestion and generally constitutes an important though not a major part of total elapsed time. Delays may be divided into terminal and road delays and are due to many things such as coaling, getting water, picking up, setting off and switching, helper service, couplers, hot boxes and blocking by trains ahead. The last may be by bar the most important single item, constituting in certain cases approximately one-half of total delays.

In view of the multiplicity of varying conditions which contribute to delays, no definite rule of estimating them can be given except the very general rule of basing the estimate on a study of past performance under simliar physical, operating and traffic conditions.

Speed-Curve Method—Speed and running time between stops may be estimated as follows:

By means of acceleration and retardation curves computed for the given engine, fuel, train-load and gradients, compute and preferably plat the speed-curve on the profile. Platting, though not strictly necessary, as computations can be made without it, has many advantages.

A profile showing the grade line, coal and water stations, other stations, number of tracks, passing tracks, curvature, etc., to a scale of 2,000 ft. to the inch, horizontally, and 20 ft. vertically, or other convenient scale, may be used.

Estimate the time by multiplying the distance in stations by the time (n) in decimals of a minute required to travel one station at the given speed. This can be measured by a scale showing values of (n) for corresponding speeds. Where the speed varies appreciably, the time should be taken for separate intervals of distance, 10 stations, 5 stations or less, as in such case the distance multiplied by the value of (n) for the average speed does not give the correct time.

Multiply the total time of engine working and drifting by the corresponding rates of fuel consumption. To this may be added fuel consumption for engine firing up and standing.

Speed-Curve Method Modified—By using the same general methods, diagrams may be constructed showing for a given engine and train, or for a tonnage constituting any number of such trains, speed, time lost and fuel consumed per foot of rise or fall on various grades as compared with the performance of the same engine and train on a level tangent. The latter is readily computed. This method is especially adapted to computations as to the negative value of rise and the positive value of fall and should accomplish practically the same result as platting the speed line on the profile, except that

stops are omitted and must be considered separately, if at all.

Line Resistance as a Measure of Fuel Consumption—Fuel consumption may be estimated on the basis of line resistance as described on page 803 of the Manual. The method may be expanded to include resistance due to accelerating trains by adding the velocity head destroyed by brakes at stops to total line resistanace in vertical feet.

This method has the advantage of great simplicity and may be useful in many problems. It is based on a uniform rate of fuel consumption per foot-ton of line resistance. But as a steam locomotive burns considerably more coal per horsepower at low than at high speeds it should be understood that this method will not indicate the full disadvantage of heavy adverse grades where low speeds prevail.

The average fuel per foot-ton of line resistance will vary with the thermal value of the coal, and for any operating division may be approximated by dividing the total line of resistance into the fuel consumed, making deductions for the amount consumed by the engine firing up, standing and accelerating from stops.

Discussion

[The report was presented by its chairman, E. E. King, who submitted the report in appendix A, on methods of estimating speed; time, and full consumption and *moved that the conclusions be adopted for publication in the Manual.*]

E. E. Kimball (Gen. Elec. Co.): I wonder if Mr. King would consider changing his definition of running time and elapsed time to running time and road time, on account of the fact that crew expense is determined sometimes from elapsed time, which is the time from the time the crew is called until the time they leave, instead of having it considered from the time of leaving the terminal.

Chairman King: The cost of the train service includes all of those items. We have included here the cost of firing up the locomotive, and I presume it would be quite proper to figure the time for the crew from the time it is called until it is discharged. I think that would be quite proper to do that.

Chairman King: It seems to me that elapsed time is the word we want.

E. B. Katte (N. Y. C.): The Committee on Electricity has co-operated with the Committee on the Economics of Railway Location. The electric locomotive will have a certain effect on railway location, but there are limitations, and these limitations the Committee on Electricity feel they can point out to the Committee on Railway Location. I have in mind a recent calculation for a mountainous railroad in Pennsylvania. There was a question of electrifying or building another track. It happened in this particular location that the loaded trains went up the grade, so that there was nothing that the increased tractive power of electric locomotive power could add to that of the steam locomotive. The increased cost of electrification made electrification in this particular instance uneconomic, and additional track was the proper solution of the problem.

[*A motion to adopt the conclusions in appendix A for inclusion in the Manual was carried.* The committee was dismissed with the thanks of the Association.]

Report of Committee on Buildings

The Committee on Buildings presented a report containing specifications for roofing which were submitted for discussion and criticism. It recommended that the specifications for concrete roofing tile, clay roofing tile, electric light wiring, hot air heating, hot blast heating, architectural terra cotta and concrete architectural stone as presented at the 1923 convention be approved for publication in the Manual. Conclusions on floors for freighthouses and enginehouses and on the location and design of signs for passenger stations were submitted for inclusion in the Manual. Data on the ventilation of railway buildings, except enginehouses, was submitted as information. W. T. Dorrance, who has been chairman of this committee for the past 5 years, has been a member for 10 years.

W. T. Dorrance
Chairman

THE COMMITTEE presented a report covering Specifications for Buildings for Railway Purposes (Appendix A), Ventilation of Railway Buildings, Except Engine Houses (Appendix B), Location and Design of Signs for Passenger Stations (Appendix C), and Floors for Railway Buildings.

The convention of last year referred back to the committee from its report on Floors for Railway Buildings, the conclusions with regard to Floors for Freight Houses and Floors for Engine Houses. The conclusions on these types of floors have been reviewed and the committee submits the following:

Freight Houses—In small houses, which are usually of frame construction, a plank floor laid on wooden joists is satisfactory and economical. In larger and more important houses, where much trucking is done, a floor of greater first cost is justified and appreciable economies in operation can be obtained by the selection of a suitable trucking surface. Concrete floors are fairly permanent, sanitary and easy to keep clean, but have as disadvantages a possible failure of the wearing surface, especially at expansion joints, and an unyielding surface which occasionally produces complaints from truckers. Expansion joints should be located outside of the heavily used surface wherever practical. If a concrete surface is not considered suitable, some different type of wearing surface such as square edge maple, wood or asphalt blocks or asphalt mastic may be laid on the concrete. A creosoted wood plank floor on a concrete base with a wearing surface of untreated maple flooring has been known to give very satisfactory service. If the cost of a concrete base is not justified an excellent floor

can be made by laying creosoted plank on a fill of cinders or gravel, the top layer of which is treated with tar or some asphaltic compound, and covering the creosoted plank with a maple wearing surface. Asphaltic concrete may be applied over a wood base with good results.

Engine Houses—In minor houses, where not many running repairs are made, a floor of clean engine cinders, well compacted, is frequently used but whenever possible a better type floor should be provided. For houses of more importance concrete floors or floors of brick or creosoted wood blocks on concrete base should be used. Asphalt floors, either mastic or block, if used in engine houses, should be of such composition as to resist the action of steam and oil.

The committee recommended that Specifications for Railway Buildings, covering the following subjects, be approved for publication in the Manual: Concrete Roofing Tile, Clay Tile Roofing, Electric Light Wiring, Hot Air Heating, Hot Blast Heating, Architectural Terra Cotta, and Concrete Architectural Stone. It recommended also that the Specifications in Appendix A be given consideration by the Association so that the committee may have the benefit of any criticisms before recommending for publication in the Manual; that Appendix B be received as information; that the conclusions and recommendations in Appendix C including diagram be approved for publication in the Manual; and that the conclusions with regard to Floors for Engine Houses and Floors for Freight Houses be approved for publication in the Manual.

Committee: W. T. Dorrance (N. Y. N. H. & H.), Chairman; J. W. Orrock (C. P. R.), Vice Chairman; G. A. Belden (C. of Ga.), A. C. Irwin (Portland Cement Assn.), Eli Christiansen (C. R. I. & P.), F. R. Judd (I. C.), F. O. Condon (C. N. R.), D. F. McLaughlin (I. C.), Arthur Crable (H. V.), G. A. Mitchell (C. N. R.), H. G. Dalton (C. B. & Q.), Milburn Moore (*Railway Age*), W. L. Darden (S. A. L.), L. G. Morphy (Rutland), F. M. Davison (C. N.), F. L. Riley (B. & O.), Hugo Filippi (W. H. Brown & Co.), G. A. Rodman (N. Y. N. H. & H.), A. M. Griffin (A. C. L.), A. L. Sparks (M.-K.-T.), E. A. Harrison (A. T. & S. F.), O. G. Wilbur (B. & O.), A. H. Williamson (F. E. C.).

Appendix A—Specifications for Railway Buildings

Section 22—Roofing

1. **General**—The contractor shall furnish all labor, material, tools and equipment necessary to entirely complete the roofing, to make the work watertight, and shall leave it in a neat and finished condition.

2. **Materials. Pitch**—Pitch shall be the best quality, straight-run American coal-tar pitch, distilled direct from coal-tar and free from water and ammonia. It shall not contain less than 15 per cent nor more than 35 per cent of free carbon. The melting point shall be not below 140 deg. F. nor above 150 deg. F. (A. S. T. M. cube method) and it shall show a flashpoint of not less than 240 deg. F.

Asphalt—Asphalt shall be a combination of natural asphalt prepared and combined properly in which inherent mineral matter will be permitted but to which no mineral matter shall be added. The melting point of asphalt shall be between 140 deg. F. and 180 deg. F. The penetration at 77 deg. F. under a load of 100 grams for 5 seconds shall be not less than 20 mm. or more than 30 mm. The ductility at 77 deg. F., when a briquette of the material having a minimum cross-section of 1 centimeter is pulled apart at the rate of five centimeters per minute, shall be not less than 10 centimeters for asphalt having a melting point under under 165 deg. F., nor less than three centimeters for asphalt having a melting point between 165 deg. F. and 180 deg. F. The loss of a 50 gram sample at 325 deg. F. for five hours shall not exceed one per cent. The penetration of the residue at 77 deg. F. under a load of 100 grams for five seconds shall be not less than 10 mm. nor more than 15 mm. The methods of making tests shall be in accordance with the standard of the A. S. T. M.

Asphalt Primer—Asphalt Primer for concrete and gysum decks shall weigh not less than seven pounds per gallon and shall be made from asphalt, of the quality specified under "Asphalt" flushed to the proper consistency. The melting point of the Asphalt Primer shall be such as will permit the subsequent application of hot asphalt to amalgamate immediately with it.

Roofing Felts—Impregnated felts shall be 32 or 36 in. wide and shall be saturated thoroughly. They shall have sufficient pliability to meet the requirements of application, and samples taken five feet from the outside ends of rolls shall bend flat without cracking through 180 deg. at a temperature of 60 deg. F. A variation of seven per cent from the weights specified will be allowed. The impregnating compounds shall be of the qualities specified and shall be of the proper consistency for saturating the felts.

Tarred and asphalted felts shall be rag felts, and for built up roofings shall weigh not less than 14 lb. per 100 sq. ft.

Unimpregnated felt or rosin sized building paper shall weigh not less than 5 lb. per 100 sq. ft.

Manufactured Roofing—Manufactured roofing material shall be delivered at the site in the original sealed packages of the manufacturer, and each package shall be wrapped and labeled properly in order that it may be identified easily.

Gravel and Slag—Gravel shall be hard, durable, free from clay, loam and other foreign substances, and shall range from ¼ to ⅝-in.

Slag shall be a granulated furnace slag, free from sand, dirt and other foreign substances, and shall range from ¼ to ⅝-in.

3. **Application**—The roof decks shall be clean, smooth, thoroughly dry and free from projections which would injure the roof coverings. All roofing shall be laid smoothly, without wrinkles or buckles, and finished surfaces shall be free from cracks and bubbles.

Before applying the roofing over wood decks, all loose knots and other flaws shall be removed and knot holes and large cracks shall then be covered with tin or other sheet metal nailed in place.

For gypsum or concrete decks, the joints and surfaces shall be made tight and flush, and all loose and uneven surfaces shall be leveled up before the roofing is applied.

Built-Up Roofing

Type A-1—Pitch and gravel (or slag) over wood or precast gypsum slabs. Roofing constructed of five layers of tarred felt, pitch and gravel (or slag) and a minimum of 150 lb. of pitch per sq. ft.

(1) If of wood, lay one thickness of rosin-sized building paper or unimpregnated felt weighing not less than 5 lb. per 100 sq. ft., lapping the sheets at least one inch; if of pre-cast gypsum, this shall be omitted.

(2) Over the entire surface lay two layers of tarred felt, weighing not less than 14 lb. per layer, per 100 sq. ft., lapping each sheet of each layer 17 in. over the preceding sheet, end laps not less than 4 in. Sheets shall be nailed as often as necessary to hold them in place until the remaining felt is laid. These layers shall be turned up vertical surfaces not less than 6 in. and securely fastened.

(3) Coat the entire surface uniformly with hot pitch, using not less than 25 lb. per 100 sq. ft.

(4) Over the entire surface lay three layers of tarred felt, lapping each sheet of each layer 22 in. over the preceding sheet, with end laps not less than 6 in. Hot pitch shall be mopped the full 22 in. on each sheet so that in no place shall felt touch felt, using not less than 25 lb. of pitch per 100 sq. ft. between successive layers. Any nailing necessary shall be done in such a manner that all nails will be covered by not less than two layers of felt. Nails shall be be galvanized and shall be driven through flat tin or zinc caps. These layers shall be turned up vertical surfaces and securely fastened.

(5) Coat the entire surface uniformly with hot pitch poured from a dipper, using not less than 75 lb. per 100 sq. ft., into which while hot embed not less than 400 lb. of gravel (or 300 lb. of slag).

Type A-2—Pitch and gravel (or slag) over concrete or poured gypsum. Roofing constructed of one coating hot pitch and five layers of tarred felt, pitch and gravel (or slag) and a minimum of 215 lb. of pitch per 100 sq. ft.

(1) The entire surface shall be coated uniformly with hot pitch, using not less than 40 lb. per 100 sq. ft.

(2) Over this lay two layers of tarred felt, weighing not less than 14 lb. per layer per 100 sq. ft., lapping each sheet of each layer 17 in. over the preceding sheet, end laps not less than 4 in. Hot pitch shall be mopped the full 17 in. on each sheet, so that in no place will felt touch felt, using not less than 25 lb. of pitch per 100 sq. ft. between successive layers. Each layer shall be cut off at vertical surfaces.

(3) Coat the entire surface uniformly with hot pitch using not less than 25 lb. per 100 sq. ft.

(4) Over the entire surface lay three layers of tarred rag felt, lapping each sheet of each layer 22 in. over the preceding sheet, end laps not less than 6 in. Hot pitch shall be mopped the full 22 in. on each sheet, so that in no place will felt touch felt, using not less than 25 lb. of pitch per 100 sq. ft. between succeeding layers.

If roof decks are of gypsum, in addition to the above, the upper edge of each course of the third layer of felt shall

be nailed to the roof deck with galvanized nails driven through flat tin or zinc caps. These layers shall be turned up vertical surfaces and securely fastened.

(5) Coat the entire surface uniformly with hot pitch, poured from a dipper using not less than 75 lb. per 100 sq. ft., into which while hot not less than 400 lb. of gravel (or 300 lb. of slag) shall be embedded.

Type B-1—Asphalt and gravel (or slag) over wood or pre-cast gypsum slabs. Roofing constructed of five layers of asphalted felt, asphalt and gravel (or slag) and a minimum of 150 lb. of asphalt per 100 sq. ft.

(1) If of wood, lay one thickness of rosin-sized building paper or unimpregnated felt weighing not less than 5 lb. per 100 sq. ft., lapping the sheets at least one inch; if of pre-cast gypsum this shall be omitted.

(2) Over the entire surface lay two layers of asphalted felt, weighing not less than 14 lb. per layer per 100 sq. ft., lapping each sheet of each layer 17 in. over the preceding sheet, end laps not less than four in. Sheets shall be nailed as often as necessary to hold them in place until the remaining felt is laid. These layers shall be turned up vertical surfaces not less than 6 in., and securely fastened.

(3) Coat the entire surface uniformly with hot asphalt, using not less than 25 lb. per 100 sq. ft.

(4) Over the entire surface lay three layers of asphalted felt, lapping each sheet of each layer 2 in. over the preceding sheet, end laps not less than 6 in. Hot asphalt shall be mopped the full 2 in. on each sheet, so that in no place will felt touch felt, using not less than 25 lb. of asphalt per 100 sq. ft. between successive layers.

Any nailing necessary shall be done in such manner that all nails will be covered by not less than two layers of felt. Nails shall be galvanized and shall be driven through flat tin or zinc caps. These layers shall be cut off at vertical surfaces and securely fastened.

(5) Coat the entire surface uniformly with hot asphalt poured from a dipper, using not less than 75 lb. per 100 sq. ft., into which while hot embed not less than 400 lb. of gravel (or 300 lb. of slag).

Type B-2—Asphalt and gravel (or slag) over concrete or poured gypsum. Roofing constructed of five layers asphalted felt, asphalt and gravel (or slag) and a minimum (not including primer) of 205 lb. of asphalt per 100 sq. ft.

(1) The entire surface, if of concrete, shall be coated uniformly with asphalt primer, using not less than 10 lb. per 100 sq. ft. and allowed to dry.

(If of gypsum, the surface shall be given two such coats.) Upon this there shall be applied a uniform coat of hot asphalt, using not less than 30 lb. per 100 sq. ft.

(2) Over this lay two layers of asphalted rag felt, weighing not less than 14 lb. per layer per 100 sq. ft., lapping each sheet of each layer 17 in. over the preceding sheet; end laps not less than 6 in. and securely fastened. Hot asphalt shall be mopped the full 17 in. on each sheet, so that in no place will felt touch felt, using not less than 25 lb. of asphalt per 100 sq. ft. between successive layers.

(3) Coat the entire surface uniformly with hot asphalt, using not less than 25 lb. per 100 sq. ft.

(4) Over the entire surface, lay three layers of asphalted rag felt, lapping each sheet of each layer 22 in. over the preceding sheet, end laps not less than 6 in. Hot asphalt shall be mopped the full 22 in. on each sheet, so that in no place will felt touch felt, using not less than 25 lb. of apshalt per 100 sq. ft. between successive layers.

If roof decks are of gypsum, in addition to the above, the upper edge of each course of the third layer of felt shall be nailed to the roof deck with galvanized nails driven through flat tin or zinc caps. These layers shall be turned up vertical surfaces and securely fastened.

(5) Coat the entire surface uniformly with hot asphalt poured from a dipper, using not less than 75 lb. per 100 sq. ft., into which while hot embed not less than 400 lb. of gravel (or 300 lb. of slag).

Appendix B—Ventilation of Railway Buildings, Except Engine Houses

In some buildings where fumes, gases, smoke, etc., are produced it is often necessary to provide mechanical means of exhausting impure and vitiated air, and of supplying fresh air. This is especially required during the heating season when means of natural ventilation mentioned above are closed or inoperative. The class of buildings in which it is satisfactory to rely on natural means of ventilation include such buildings as freight houses, machine shops, storehouses, office buildings, blacksmith shops, foundries, car repair shops, carpenter shops, etc. It may be desirable or necessary in some cases to provide local ventilation by means of exhaust fans in such buildings as oil houses, paint shops, blacksmith shops and foundries.

All toilet buildings and toilet rooms should be adequately provided with means of natural ventilation and where natural ventilation is insufficient to maintain a healthful atmosphere, it should be supplemented by exhaust fans to remove objectionable odors, especially in toilet rooms in connection with passenger stations or other places where facilities are provided for the public.

Kitchens and serving rooms should be properly ventilated and for this purpose exhaust fans are frequently used to remove heat and odors of cooking, which if not removed mechanically will permeate the atmosphere of adjacent dining rooms and other portions of the building. This mechanical ventilation may also be necessary to maintain proper working conditions for kitchen employes.

In case of through stations with station building located over the tracks, it is sometimes necessary to install an exhaust system of ducts and fans to remove the smoke and gases caused by engines from under the building.

Where station facilities are below ground level it will usually be necessary to install a mechanical system of ventilation to exhaust vitiated air and to provide an adequate supply of fresh air.

Large office buildings and passenger terminals are sometimes equipped with mechanical ventilating systems in connection with heating systems. Such equipment provides washed and tempered fresh air and exhausts the vitiated air.

It is problematical if the large expense of such installations and maintenance of same is justified as their efficient functioning is often interfered with by the injudicious use, locally, of natural ventilation in the majority of large buildings of this kind. Satisfactory ventilation may be obtained by designing the building in such a manner that full advantage is taken of all the various means of natural ventilation by which sufficient changes of air may be effected to maintain the air of any room in healthful condition.

Appendix C—Location and Design of Signs for Passenger Stations

General Requirements

With the development of aviation the question of marking railroad stations for the guidance of fliers presents itself. The United States Army Air Service is endeavoring, through counsel with various organizations, to establish a system of markers, and through the American Railway Association has outlined a method of meeting the requirements through the co-operation of the railroads, as follows:

(a) By obtaining permission to place markers on the rights-of-way of railroads.

This method would consist of placing the name of the town on the railroad right-of-way parallel to the tracks in letters of sufficient size to be read from a height of several hundred feet.

(b) By obtaining permission to paint the names of towns on the roofs of passenger or freight stations or other suitable railroad buildings.

(c) By re-arranging the station signs now on ends of stations so as to bring same out from under the eaves and increase their visibility.

Types of Signs

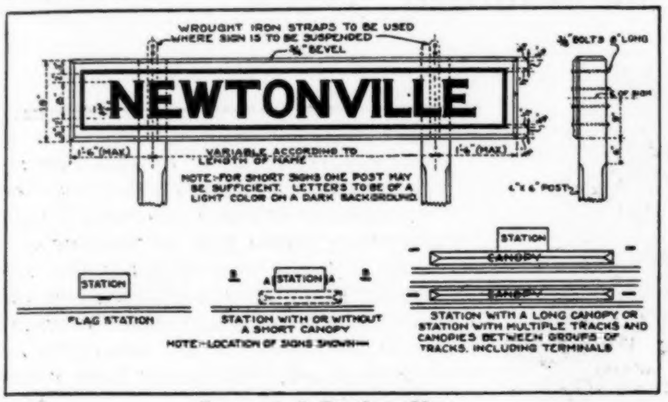
The types of signs at present in use vary from the elaborate marking of some of the large terminals to the simple sign painted on the side of the small station building.

The types of signs most commonly in use, however, are:

(a) Names of the stations painted on the walls of the buildings.
(b) Built-up signs attached to the buildings, canopies or other structures.
(c) Letters of heavy white glass bedded in the wall of the buildings with lights back of same.
(d) Ornamental names made a part of the architecture of the buildings at larger terminals.

The distance from main terminals, if desired, is shown in smaller type at each end of the name of the station on all types.

There appears to be a tendency to make more extensive use of the built-up signs attached to the buildings or structures, and to make use of block or other simple



Suggested Station Sign

letters of a light color on a dark background. These signs give very good results because they can be seen at long distances and because they are economical to maintain.

Signs should be located where they may be seen easily by the traveling public.

Conclusions and Recommendations

At flag stations or small stations without canopies it is recommended that one sign facing the track be installed, this being considered sufficient.

At larger stations without or with a short canopy it is recommended that signs be installed as follows:

(a) On each end of the building and at right angles to the track, bearing in mind visibility from the air.
(b) Signs erected on posts at some distance from each end of the building and parallel to the track.
(c) At junctions, or for some special reasons, it may be desirable to erect signs as recommended under both (a) and (b).

At stations with a long canopy, or stations with multiple tracks and canopies between groups of tracks, including terminals, it is recommended that sufficient signs be erected on posts beyond the ends of the canopies and parallel to the tracks. At such stations the character of the main buildings is usually such that an ornamental architectural name on the building should be sufficient.

The use of built-up signs with letters of a light color on a dark background is recommended, and care should be exercised to use a background of a dull or non-reflecting surface. Blue or black smalts give very good results in this respect. The showing of distance from main terminals or other information on station signs is not recommended.

The diagram illustrates the recommended uses of signs and a type of built-up sign.

Discussion

(The report was presented by W. T. Dorrance, chairman, who *moved that the specifications for concrete roofing tile, clay tile roofing, electric light wiring, hot air heating, hot blast heating, architectural terra cotta and concrete architectural stone be approved for publication in the Manual. The motion was carried.*)

S. T. Wagner (Reading): I am glad that the specification in Appendix A will be held over until next year. Committee D-8 of the A. S. T. M., whose duty was formerly to prepare specifications for waterproofing, has within the last year had its scope enlarged so as to include roofing materials of a bituminous nature. That committee is now seriously at work on that question and will present at the next convention at Atlantic City several specifications for bituminous roofing material. Those specifications coming from the A. S. T. M. apply only to the materials and not to the application, but I feel sure that the report of that committee, which will be available in the next three or four months, will enable this committee to obtain some more light on the subject, especially from the manufacturers of roofing materials.

L. J. F. Hughes: The recommendation specifies that signs should be placed "on the end of the building and at right angles to the track, bearing in mind visibility from the air." Does that mean that these signs shall be placed so that they will be visible by aeroplanes, or is that for something else?

L. G. Morphy (Rutland): That means that it should be, if possible, so located that a man from an aeroplane may be able to locate himself by those signs. If you will refer to general requirements, you will see that the subject of being able to locate and identify the places from the air is mentioned and you will also notice that the U. S. Army Air Service is endeavoring through various organizations to establish such practices.

President Ray: This question of properly marking stations was brought up by several outsiders, people who were not members of our Association. It has been presented to us in various ways. There was a cartoon of a gentleman craning his neck during the night to try to find out what station he was passing through on the sleeper. That cartoon was sent to me by at least half a dozen different people, all of them outside of railroad service.

Those who are acquainted with any individual railroad generally can locate themselves at any time in the night by other things than signs on stations, but the traveler is in a very different position and people traveling on the lines are always interested in finding out where they are, so the question of properly placing signs on stations, ought to receive careful consideration before it is adopted.

C. C. Cook (B. & O.): The committee suggests that they make use of block or other simple letters. In the diagram it shows a block letter with a full line. I would like to know whether it prefers the block letter as compared to a light line or shaded letter.

Mr. Morphy: In regard to the type of letter, a block letter without shaded lines appears to be better, that is, a sign with the single stroke letter seems to be advisable and more readily made out than one with a shaded line. It is very possible that at large stations and large terminals where architectural effects are desirable, a different type of sign will be inscribed right on the building itself, but this block letter is suggested as the wheel horse. It is one that is most useful in most of the places where such signs might be erected.

E. B. Katte (N. Y. C.): About 15 years ago when the New York Central was modernizing and bringing up to date the suburban stations at the time of electrification, illuminated station signs were given a great deal of consideration. A simple block letter, blue enamel sign was used and illuminated at night. Only two stations were thus equipped. The traveling public didn't seem to pay any attention to it at night, the expense did not seem justified, and the New York Central didn't find it advisable to continue the practice.

Mr. Morphy: This committee does not recommend the wholesale use of illuminated signs in this report. The only thing is that at such places where signs are placed on posts at stations and parallel to the track, if

the canopy and station is naturally illuminated and no extra expense is involved, it would seem desirable to have the sign erected where a light would be in any case. No recommendation has been made for general illumination.

J. M. Metcalf (M. K. & T.): I should like to inquire why the committee recommends placing the signs on posts parallel to the track. It occurs to me they are more visible either from train or air when placed at right angles to the track.

Mr. Morphy: Actual observation is what led us to the conclusion that a sign parallel to the track, particularly where you have inter-track canopies and platforms is much more readily made out by a passenger on the train than one at right angles to it.

(A motion to accept the conclusions and recommendations in regard to signs for inclusion in the Manual was made and carried.)

Chairman Dorrance then presented the revised conclusions on floors for freight houses and engine houses and *moved that they be accepted for publication in the Manual. The motion was carried.* (The Committee was dismissed with the thanks of the Association.)

Report on Stresses in Railroad Track

As has been the case since its organization in 1914, the Committee on Stresses in Track has co-operated with a special committee of the American Society of Civil Engineers and this year presented its fourth report. This report, while giving a detailed analysis of the complex problems in track, was submitted, however, as a progress report since there is still much work before the committee upon which it will report at future times. The report this year gave further data on the stresses in track produced by the action of steam and electric locomotives. It also presented the first scientific study of the effect upon rail and upon track maintenance resulting from the canting of rail inward. Professor A. N. Talbot has been chairman of this and the A. S. C. E. committee since they were organized.

A. N. Talbot
Chairman

THE REPORT of the committee as presented represented the fourth progress report on stresses in railroad track. The work reported on included data on tests made on the Chicago, Milwaukee & St. Paul in the vicinity of Lennep and Loweth, Mont., and on four eastern railroads, namely, the Baltimore & Ohio, the Richmond, Fredericksburg & Potomac, the Reading and the Lehigh Valley. The purpose of the tests on the St. Paul was to obtain data by which the effect on straight track and on medium and sharp curves produced by the several types of electric locomotives run at different speeds could be judged and compared with each other and with a Mikado type of steam locomotive. Stresses in the rail under and between wheels and for both vertical and lateral bending of the rail were determined and various other observations bearing on the action of the rail and the locomotives were made. The tests on the eastern roads were undertaken mainly with the view of obtaining information on the effect of canting rail inwardly upon the stresses in the rail and upon other matters affecting track maintenance as compared with results found with the upright rail. The tests also gave information on the action of track laid with the heavy rail used on three of the railroads. The complete report is a voluminous document consisting of a total of 165 pages and containing 103 figures and 17 tables. Only the summaries of the eastern and western tests are given here.

Committee: Arthur N. Talbot (Univ. of Ill.), Chairman; W. M. Dawley (Erie), Vice Chairman; G. H. Bremner (C. B. & Q.), C. B. Bronson (N. Y. C.), John Brunner (Ill. Steel Co.), W. J. Burton (M. P.), Chas. S. Churchill (N. & W.), W. C. Cushing (Penna.), C. W. Gennet, Jr. (R. W. Hunt Co.), H. E. Hale (Pres. Conf. Com.), J. B. Jenkins (B. & O.), George W. Kittredge (N. Y. C.), Paul M. LaBach (C. R. I. & P.), C. G. E. Larsson (Am. Bridge Co.), G. J. Ray (D. L. & W.), Albert F. Reichmann (Am. Bridge Co.), H. R. Safford (G. C. L.), Earl Stimson (B. & O.), F. E. Turneaure (Univ. of Wis.), J. E. Willoughby (A. C. L.).

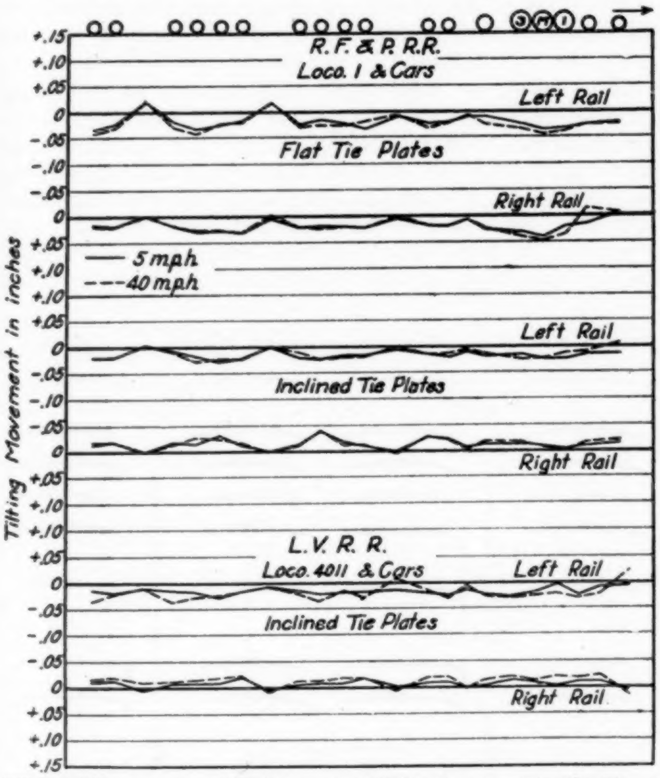
General Discussion of the Tests on the C. M. & St. P.

The mean stress in base of rail on straight track at the low speed as determined in the tests had much the same value as that found by calculation by the analytical method using the nominal loads, the differences rather emphasizing the variations from the nominal loads that may occur. The influence of the close spacing of wheels in decreasing the stress in rail is well illustrated by locomotives 10254 (G. E. passenger) and 10221 (G. E. freight), the stress under a driver of the former being only about 50 per cent of that which would be developed if the wheels were very far apart while that under the drivers of the latter was about 85 per cent of a corresponding value. The average of the mean stresses in the outer and inner rails for all the wheels on the curved track did not differ much from the calculated values, being somewhat greater on the 10 deg. curve.

The mean stress in base of the 90-lb. rail under the drivers on straight track at 5 miles per hour ranged from 8,000 lb. per sq. in. for the General Electric passenger locomotive and 12,000 for the Mikado type (not including counterbalance effect) to 15,500 for the Westinghouse-Baldwin locomotive (with an average stress for one driver of 19,700 lb. per sq. in.) and 17,000 lb. per sq. in. for the General Electric freight locomotive. The mean stress in the rail at the same speed under the wheels of the loaded freight cars with a wheel load of 18,500 lb. averaged 11,000 lb. per sq. in. There was, of course,

a belt of values with a range above and below the average value reported for any wheel of locomotive or cars.

The increase in stress in rail with increase in speed was relatively small for all the locomotives. It may be remarked that variations may be expected in the values of the ratios, as there are many variable conditions in such tests, this being especially true when the measured stresses are small; thus, for a stress of 8,000 lb. per sq. in. an increase of 10 per cent is only 800 lb. per sq. in. and changing conditions may easily make differences nearly as great as this. For the passenger locomotives (except for 10302—the Westinghouse-Baldwin), the increase in stress on straight track from 5 to 60 miles per hour may be said to be about 12 per cent. The corresponding increase in stress was about 1,500 lb. per sq. in.



Tilting Movement of Rails on Straight Track. Pacific Type Locomotive and Cars (R. F. & P.) and Santa Fe Type Locomotive and Cars (L. V.)

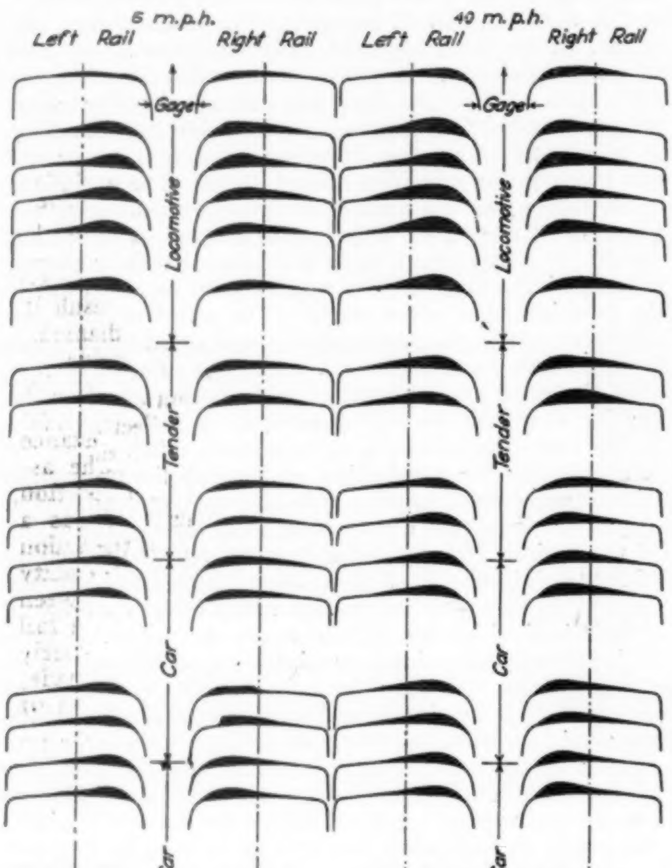
The speed effect from 5 to 40 miles per hour was relatively smaller. That of the General Electric freight locomotive was not large. That of the Mikado locomotive was larger, but was only 10 per cent; this does not include the effect of counterbalance. On the 6 deg. curve the speed effect differed but little from the value for straight track. The 10 deg. curve gave a somewhat higher value, but the difference is not marked. The values for loaded freight cars on straight track and 10 deg. curve are greater, but for these the increase in mean stress is only 13 and 25 per cent, respectively. All of these values of the effect of speed are smaller than were obtained in former tests. It should be borne in mind that the values noted are all average values; in all the locomotives and cars there are increases under individual wheels that are much larger than the average given.

The relation of the speed effect for dead or unsprung load to that carried on effective springs is of interest, as is also the relation of diameter of wheel to speed effect. It is frequently stated that the effect of speed on track is inversely proportional to the square of the diameter of the wheel and directly proportional to the dead weight carried. Sometimes the first power of the diameter is given instead of the square. The unsprung weight carried by one driver of the General Electric freight locomotive is 8,100 lb. equal to 29 per cent of the average total load on the driver, the corresponding values for the General Electric passenger locomotive being 4,800 lb. and 24 per cent, and for the Westinghouse-Baldwin passenger locomotive 3,900 lb. and 12 per cent. The diameters of the drivers of the three types of locomotive are 52, 44 and 68 in., respectively. A study of the values and of the other data of the tests does not indicate that the effect of speed on bending stresses in rail varies with diameter of wheel and proportion of unsprung weight to the extent given by the principles quoted above. The variations in the values due to a number of causes do not permit the effect of diameter of wheel and amount of unsprung weight to be segregated, but it is evident that their effects, although important, are far smaller than would result if the principle cited were sound. The effect of diameter of wheel, within the limits of size and speed considered, from analytical considerations would not seem to be very great for good track, whatever might be the effect on the bearing strains in the rail (detrusion) or in the resistance to traction—the latter being relatively small. The assumption that the speed effect varies with the proportion of unsprung load implies that the sprung load has a negligible effect, thus overlooking the defects of the action of the springs and equalizing systems and the flexibility of the track itself. Doubtless, too, a load applied between the wheels of a pair exerts less speed effect on one rail than if half of it were applied to the one wheel. Poorly designed and maintained equalization systems and inadequate springs, too, may detract from the usefulness of springs. It is not intended by these remarks to belittle the need for providing adequate springs for a large proportion of the load. It may be added that the condition of the track surface must have an important influence on the speed effect; uneven track, that is, track with a succession of hard spots and soft spots, may be expected to give large speed effects. Attention should also be called to the advantage of having adequate easement curves when the proportion of unsprung weight is large, particularly when this weight is low, as when it is carried directly on the axle.

The foregoing discussion relates to the average values of the mean stress in base of rail. Due to the lateral bending of the rail, the ratio of stress at outside edge to mean stress will vary. On straight track the average of these ratios for the various wheels of the several locomotives ranged from 0.82 to 1.33, the former being under the trailer of the Mikado locomotive and the latter under a driver of a Westinghouse-Baldwin passenger locomotive, the lateral bending stress in the latter case having a value of 4,500 lb. per sq. in. The ratios were generally different for the two sides of the locomotive, sometimes markedly different, and the ratio at one wheel differed from that at another. Generally there were one or more wheels in each locomotive that gave a markedly higher outward lateral bending of the rail than the others, the reason for the higher stresses not being apparent.

Also for a given wheel the individual observations of lateral bending stresses in the rail of straight track varied widely from the average stress corresponding to the average ratio just considered. Lateral bending stresses as great as 9,000 lb. per sq. in. were found in connection with a mean stress or vertical bending stress of 22,000 lb. per sq. in., making a stress of 31,000 lb. per sq. in. at the outside edge, though there were few of this magnitude. It is evident, of course, that these lateral stresses and the accompanying lateral movement of the rail are factors which produce stresses and movements in ties and ballast and thus affect track maintenance and also enter

into the maintenance requirements of the locomotives. It may be said, however, that the lateral bending stresses and lateral movements found in the tests with these locomotives are in general less than have been found in some of the tests of straight track made previously. With



Bearing of Wheels on Rails With Flat Tie Plates on Straight Track

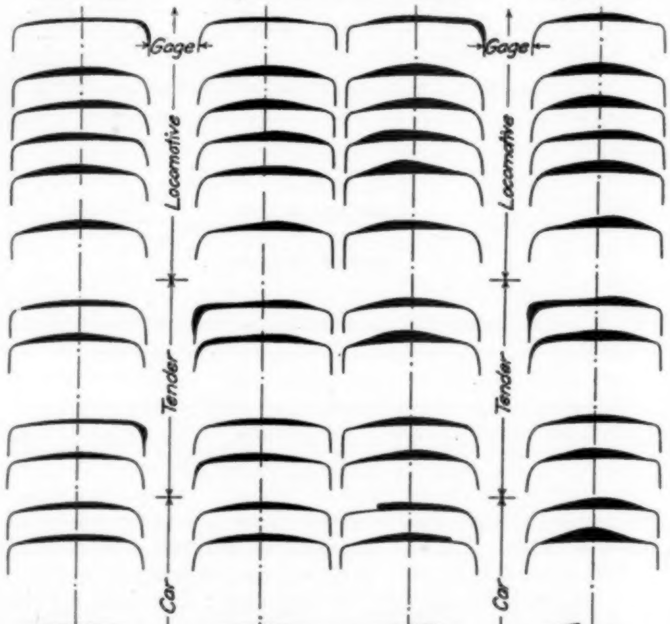
the electric locomotives the absence of stress due to counterbalance was especially noticeable.

It is to be expected that with the great diversity in wheel loads, wheel spacing, wheel grouping, and articulation of running gears and devices for regulating flexibility the four types of locomotives in traversing the curved track will show a variety in the magnitude and distribution of the lateral bending stresses in rail, in the division among the wheels of the work of guiding the locomotive around the curve and in effecting the lateral slip of the wheels on the rail which is an essential element in negotiating a curve. Differences may be expected in the flexibility of the locomotives, both as a whole and in their various parts, and also in the effect on the alinement of the track and its necessary maintenance. A discussion of the effect of the details of design of the different locomotives and their influence on the track as shown by the tests can not well be taken up at this time. The mechanical departments of the railroads and the builders of locomotives have long given attention to the requirements of locomotives for traversing curved track. The results herein reported may be expected to be of service in the further improvement of details of this part of locomotive design.

The tests show that the lateral bending stresses in the rail on curved track, and therefore the lateral pressures on the rail, are relatively very great. For the curves used (6 deg. and 10 deg.) relatively large lateral pressures on the rail must be accepted as a necessity; the problem is how by proper design and maintenance to keep the values as small as possible and to make the track structure as resistant as is feasible.

All the locomotives behaved well in traversing the curved track even at the highest speed run, though, of course, there were differences noticeable. The speeds of 50 miles per hour on the 6 deg. curve and 40 miles per hour on the 10 deg. curve run by the passenger locomotives were rather high, in view of the superelevation used, but the locomotives ran the curves very smoothly except where the alinement was not good. The speed corresponding to the superelevation of the track was only three-fifths of the maximum speeds run, but the tests do not indicate that the maximum lateral bending stresses were unduly increased by reason of this difference.

The effect of imperfect alinement in parts of the curved track on the behavior of the locomotives, as in the vicinity of the pile bridge on the 10 deg. curve, and also the effect of an easement curve that was imperfectly kept up serve to emphasize the importance of maintaining excellence in line and surface if trains are to be operated at high speeds around such curves. At the higher speeds it appears also that easement curves of



Bearing of Wheels on Rails With Inclined Tie Plates on Straight Track

adequate length are very useful in adjusting the trucks and coupling connections to take the curve under the best conditions and thus to reduce the wear of both locomotive and track.

The tests have again brought out the inter-relation of

quality of maintenance of both track and rolling stock to effects of traffic on the maintenance of both and thus emphasize the value of keeping up a high standard of excellence in the maintenance of track and of locomotives and cars. High excellence in the make-up of the track structure and in the design of locomotives and cars likewise contributes to low maintenance costs.

Discussion of Canting Rail and of Unsymmetrical Tie Plates on Straight Track

In discussing the tests a distinction should be made between the purpose and effect of canting the rail and of using unsymmetrical tie plates. It will be evident that the two give separate and apparently not closely related effects.

A study of the results shows that for the rails laid on inclined tie plates the averages of the ratios of stress in outer edge to mean stress in base of rail are either close to unity or less than unity, and that the averages of the ratios for the rails laid with flat tie plates is greater than unity and greater than those found in rails laid with the inclined tie plates. In other words, the lateral bending of the rail canted inwardly of the track on the average is very small or the bending is inward, the latter being found when the rail is canted more than 1 in 20; and for rail laid vertically the outward lateral bending stresses on the average are quite marked. It may be expected that the maintenance of track affected by lateral bending of rail will be influenced by the two classes of tie plates in much the same way as is the lateral bending of the rail.

It is also evident that the bearing of wheels on the rail is closer to the middle of the head of the rail when the rail is canted inwardly than when it is vertical. This result was quite marked and was common for the drivers and the wheels of the tenders and the loaded freight cars. The distribution of brightness and of the wear over the head of the rail on the track tested covered a greater width of the head for the canted rail than for the vertical rail.

The actual cant of the rail as measured in the track differed from that indicated by the design of the tie plates, whether they were flat or inclined. This variation in the position of the rail may be expected to be attributable to other sources than the inclination of the tie plate itself—probably, as will be seen, to the amount of eccentricity of the tie plate.

So far as the data of the tests are conclusive, an inward inclination of the tie plate of 1 in 20 is effective on straight track in reducing the average value of the lateral bending stresses in the rail and in securing bearing on the rail that is fairly near central.

There is no evidence that the canting of the rail has an effect on the general lateral movement of the rail or on changes in gage, either narrowing or widening, except possibly as a slightly greater eccentricity of tie plate may be needed in the case of the inclined tie plate to prevent outward tilting of the rail.

It should be remembered that the average lateral bending stresses referred to as being small when the rail is canted 1 in 20 and as being greater when the rail is vertical are the averages of a number of runs. Whether the rail is canted or not there will still be the variation on either side of the average. If the average ratio of stress at outside edge to mean stress in base of rail is 1.00, there will still be a belt of values ranging from as much as a 20 per cent greater stress at the outside edge to a 20 per cent greater stress at the inside edge, with many occasional values as great as 30 per cent more and less than the average, and some even greater variations. If the average ratio with a flat tie plate were 1.10 the corresponding upper range would reach to a stress at the outside edge of base of rail 30 per cent greater than the mean stress for the ordinary upper limit with other still greater additional stresses. Even if the average lateral bending stress is small, it is seen that there will still be need for adequate lateral strength and stiffness in the rail. The use of tie plates with the proper inclination will not remedy this situation.

Independently of the lateral bending of the rail just considered, as the load passes by there is a tilting of the rail inwardly or outwardly due to the greater bearing pressure on the tie under the tie plate at one side of the rail or the other than on the other side and the consequent greater depression of the tie plate at that end. If the load were applied to the middle of the head and were vertical the design of the tie plates should be symmetrical with respect to the rail. When the resultant force applied to the rail is inclined outwardly of the track, the use of a symmetrical tie plate may result in an outward tilting of the rail and a widening of the gage. The use of an unsymmetrical tie plate having the greater projection on the outside of the rail will tend to correct this condition. Too great an eccentricity in the tie plate will result in an inward tilting of the rail. The modulus of elasticity of the wood of the tie when compressed across the grain is small in comparison with that lengthwise of the grain, say one-fiftieth part, if the detrusion of the tie plate due to bearing pressure is included. As a result, small differences in the distribution of pressure along the tie plate will throw it out of level and result in a tilting of the rail and finally a permanent depression of one end of the tie plate and a cutting of the tie. What eccentricity of tie plate will be most satisfactory is a matter to be determined by experience. The observations made on the tilting of the rail in the tests, however, may be of service in judging of what may be considered a proper value for most conditions.

For the tests on all four railroads with both flat tie plates and inclined tie plates, the tilting of the rail as the load passed by was inward in all cases except for the low rail of the R. F. & P. laid with flat tie plates having ¼ in. eccentricity, which was found to have an outward cant of 1 in 30 and which tilted outwardly under load due in all probability to the lateral component developed by the transverse inclination of the track. Almost without exception on all the track the inward inclination of the rail from the vertical was greater than that due to the form of the tie plate. It would seem then that the increase in the cant of the rail is due to continued tilting under the passage of trains and uneven pressure on the tie. The tests made heretofore on track with symmetrical tie plates and without tie plates have shown a slight outward movement of the rail, and it is common experience that the gage on such track generally widens.

From the data available it may be concluded that for both flat tie plates and inclined tie plates the tie plates should be unsymmetrical. It may be concluded also that with the rails and tie plates used an eccentricity of 0.5 in. is too great. Possibly ¼ in. may be nearer the proper amount. It would seem better to state the eccentricity of the combination in terms of the position of the wheel bearing, the cant of the rail and the eccentricity of the tie plate itself. For the size of rail and tie plate used in the track tested, it may be judged that 0.75 in. is a proper value for the nominal eccentricity. With the 130-lb. rail this is about 1/10 of the height of the rail and tie plate. With a cant of 1 in 20 and a central wheel bearing on the rail, an eccentricity of tie plate of ¼ to ⅜ in. would result. Whether this eccentricity of tie plate will give proper conditions may best be told by experience.

Discussion of Canted Rail and of Unsymmetrical Tie Plates on Curved Track

The study of the data has shown that the center of the bearing of the wheel on the rails of the curved track tested is more nearly at the middle of the head of the rail when the rail is canted inwardly than when it is vertical. It is apparent from the tests that a cant of 1 in 20 will give a satisfactory bearing position for the wheels of the locomotives and cars used in the tests. The position of the wheel bearing does not differ greatly whether the flange of the wheel runs close to the rail or not, except in the case of locomotives having worn driver tires. In the case of rail that is normal or nearly normal to the transverse section of the track, the position of the center of wheel bearing ranged from 0.25 to 0.60 in. inwardly of the middle of the head of the rail, 0.50 in. being a common value. It is also apparent that in curved track as in straight track a cant of 1 in 20 will bring the center of the wheel bearing close to the middle of the head of the rail. The appearance of brightness over the head of the rail and the distribution of the wear also favored the canted rail. This is well shown in the 1 deg. curve of the Reading laid for the purpose of observation on effect of canting, where the part laid with inclined tie plates showed brightness over the full width of the head and that laid with flat tie plates showed brightness only over two-thirds and three-fifths of the width. It was also found that on the two 7 deg. curves of the B. & O. the lateral bending stresses in the rail laid with inclined tie plates were somewhat less than those found when flat tie plates were used. It is not apparent that canting the rail will have any marked effect on the rapidity of wear of the gage side of the outer rail by the flanges of wheels which bear against it and guide a truck or group of wheels in traversing the curve, except as the decrease in lateral bending stresses may show a reduction in flange pressures. Taken altogether the tests indicate that for curved track the canting of the rail conduces to a wider distribution of the bearing pressure on the head of the rail and a more favorable distribution of wear, and thus may be expected to improve track maintenance.

It is not apparent that canting of the rail has any marked effect on the tilting of the rail under load or on changes in gage by traffic or on tie cutting. It should also be noted that the variation in lateral bending stresses for different runs and different points along the track is present both in track having vertical rail and having canted rail and to approximately the same degree.

Except for certain wheels of the locomotive, the action of the wheels was to tilt both outer and inner rail inwardly of the track a small amount, thus narrowing the gage at the wheels. In the same way for the same wheels there was a movement of both rails inwardly of the track, also tending to narrow the gage under these wheels. This condition was found to exist with both vertical and canted rail. This inward tilting and lateral movement of the rail may be attributed to the position of the tie plate. If it is generally characteristic of such track, the inference may be drawn that for resisting the lateral forces present when this tilting takes place the eccentricity of the tie plate is too great. Other circumstances point to another conclusion, at least for the inner rail.

It was noted that in general the cant found on the curved track was less than that which would be expected with the tie plates used. The inclined tie plates had an inclination of 1 in 20—generally the rail was found to be canted less than this. The rail laid with flat tie plates was usually found to be canted outwardly. It is reasonable to assume that when the rail was laid its position approached that which would be expected for the tie plates used. This being true, it would seem that curved track tends to lose its cant under traffic, or to gain an outward cant, and thus to widen the gage slightly. This change is opposite to that found in straight track, where the tendency is toward an increase in cant. It is also contrary to the tilting action found on curved track under most of the wheels. It seems evident, however, that there is a tendency for the rails of curved track to lose their cant or to become canted outwardly.

The reduction in cant may be due in part to the large outward pressures exerted on the outer rail by the flanges of the guiding wheels of the locomotive and on the inner rail by the intermediate drivers that resist the pressures exerted by the outer wheels of the locomotive. That these forces are important is borne out by the outward tilting and outward movement of the two rails under these wheels.

In the matter of the proper amount of eccentricity to be given in the design of tie plates it would seem that this can best be determined in practice by the results of experience on such track as that on which the tests were conducted. If it is found that the cant of the rail is decreased under service, it would be proper to increase the eccentricity of the tie plate; if the cant shows a gain, the eccentricity may be too great. On the track used in the tests in a general way it may be said that the cant had increased on straight track and decreased on curved track.

As in the case of straight track it is of prime importance to have tie plates of adequate length. Increasing the length will not only give increased bearing area, but the greater length will have a beneficial effect by reason of the decreased variation in pressure at the ends of the tie plate corresponding to the variations in the direction of the resultant wheel load under the diverse conditions of traffic. In any case the thickness of tie plate must be sufficient for the purpose.

Stresses in Heavy Rail

The average values of the stresses in the 130-lb. rail under all the drivers of the locomotives were generally in accordance with values calculated by the analytical method given in the first progress report. Different track locations gave small differences in the average values, due partly to differences in the relative values of the positive and negative moments at and between wheels at the different locations. The values of the stresses under the individual drivers differed from the analytical results, showing a variation in the division of the load from the reported loads. As the stresses were relatively small, the variation from average values may be expected to be greater than for the lighter rail, due both to the variations in the track and to observational error.

It has been shown that the average stresses in the 130-lb. rail under the drivers on straight track were about 8,000 lb. per sq. in. These increased to 9,000 or 9,500 at 40 miles per hour. The increase due to speed was variable, but was small, the average increases ranging from 12 to 20 per cent. Mean stresses in base of rail under the drivers were found as great as 16,500 lb. per sq. in. at 40 miles per hour, and the stress at one edge as great as 22,000 lb. per sq. in. The range of individual observations above and below the average mean stress was generally not more than 3500 or 4000 lb. per sq. in. At each instrument the range was much less than this, in some cases being not more than 1,000 lb. per sq. in. above and below the average for the instrument.

As would be expected from analytical considerations, the intermediate wheels of the two trucks at the ends of two cars, or of car and tender, developed lower stresses in the rail on straight track than did the first and last of the group. On the B. & O. the mean stresses in base

of rail under the wheel load of 18,500 lb. ranged from 5,000 to 7,500 lb. per sq. in. at 5 miles per hour and 5,500 to 9,000 lb. per sq. in. at 40 miles per hour. On the Reading the mean stresses under the wheel load of 25,000 lb. ranged from 6,000 to 10,000 lb. per sq. in. at 5 miles per hour and 6,000 to 11,000 lb. per sq. in. at 40 miles per hour. The effect of speed in the latter case was very low. It is seen that with the wheel load of 25,000 lb. the stresses in rail on straight track were nearly as great as any found under the drivers of the locomotive.

In the outer rail of the 7 deg. curves of the B. & O. average vertical bending stresses of 9,000 and 10,000 lb. per sq. in. were developed under a driver of the Mikado type locomotive at speeds of 5 and 40 miles per hour, respectively, and average stresses at one edge of 12,000 and 14,000 lb. per sq. in. at the two speeds. In the inner rail average vertical bending stresses of 13,500 and 11,000 lb. per sq. in. were developed at speeds of 5 and 40 miles per hour, respectively, and average stresses at one edge of 23,000 and 14,000 lb. per sq. in. at the two speeds. Comment may be made that except for the stress of 23,000 lb. per sq. in. the stresses on the 7 deg. curve were relatively low. In the outer rail of the 10 deg. curve of the L. V. the highest average vertical bending stress under a driver of the Santa Fe type locomotive was 11,200 lb. per sq. in. at 35 miles per hour. In the inner rail an average vertical bending stress of 21,500 lb. per sq. in. and an average stress at one edge of 31,500 lb. per sq. in. were found at 5 miles per hour. At 35 miles per hour the corresponding stresses under this driver were 11,000 and 12,000 lb. per sq. in. It should be borne in mind that this inner rail was badly worn, having been relaid from the outer rail.

The cars with wheel load of 18,000 lb. developed stresses in both rails of the 7 deg. curve of the B. & O. that were lower than the stresses found under the drivers, both vertical bending stresses and stresses at one edge. Similarly on the 10 deg. curve of the L. V. the wheel load of 24,000 lb. developed stresses that were considerably smaller than those found under drivers of the Santa Fe type locomotive.

Discussion

[Chairman Talbot presented the report and reviewed various portions of it in some detail. In response to a call from President Ray, H. A. Houston of the Westinghouse Electric & Manufacturing Co. discussed the report from the standpoint of the operation of electric locomotives, and following a brief reply by Chairman Talbot, Hunter McDonald (N. C. & St. L.), on behalf of the Board of Directors, presented a resolution expressing the Association's appreciation of Professor Talbot's work. *His motion that this be adopted was unanimously carried.*]

Report on Co-operative Relations with Universities

The Committee on Co-operative Relations with Universities which was formed 2 years ago, making its first report last year, reported considerable progress in working out the elaborate problem which has been assigned to it. The purpose of this committee is to stimulate a greater interest and appreciation on the part of railway officers for the value of technically trained men in their organizations, to secure a more general application of the laboratory and other research facilities of the universities to the solution of railway problems and to stimulate a greater interest among engineering students in the business of transportation. The personnel of the committee includes both railway and college men. R. H. Ford has been chairman of this important committee since its inception in 1923.

R. H. Ford
Chairman

THE COMMITTEE presented the following report as information for the Association:

As heretofore, efforts have been continued to strengthen and broaden the contact of the American Railway Engineering Association with the colleges and universities. Members of the committee and, through its agency, other members of the Association, as representatives of the Railway Transportation Industry, have addressed the student bodies and met with the academic staffs at a gradually increasing number of college institutions.

Committee members have met with Mr. W. M. Wickendon, director of investigation for the Society for the Promotion of Engineering Education which, in co-operation with the Carnegie Foundation, is engaged in a most comprehensive and thorough-going survey of Engineering Education, the results of which give promise of being the most far-reaching effort ever undertaken in technical education.

There appears to be a decided tendency throughout industry for carefully-planned educational research as applied to the particular group under review, with a view to utilizing to the best advantage the product of the colleges and universities, the result of which is that there is an increasing appreciation of the value of these agencies for the training, development and selection of those men for their service who show natural tendencies and capacity for industrial leadership.

The objective of this research work is to enable the colleges to obtain a more definite conception of the requirements of industry, in order to determine what should be the proper training for those who may desire to enter their service, as well as to acquaint the colleges and students with what may be fairly expected as a career in their particular line of industry.

Probably at no time in the history of American technical education have the colleges and universities co-operated so fully as now in self-examination of their meth-

ods for imparting knowledge and, in turn, the leading industries are apparently obtaining a clearer conception of their own needs, as well as the desirability for co-operation with these great training agencies. Perhaps the purpose may be generally stated as to enable industry, on the one hand, to have an accurate understanding of what may be reasonably expected of the colleges, and the colleges, on the other, to be properly informed as to industrial requirements.

One of the primary mediums, in this respect, is carefully prepared research questionnaires of a more or less comprehensive character, from which extensive information is being collected, as to the requirements of the particular industry under review which, in turn, is being reflected to the colleges and universities.

The committee is working on several plans for co-operation on somewhat similar lines, but is not yet ready to report theron.

College training, formerly restricted to the few, has, of late years, developed into a great democratic institution for the many, and it is to be hoped that, through the work of this Association, railway transportation may reap its proportional benefit from these great schools for mental and physical development of specially-trained men and that, through careful and well-directed effort, our co-operation with these training institutions of higher learning may result in reaching such of their students as are best fitted for the railway service, and instilling in them a thoroughly grounded knowledge of the science and art of Railway Transportation, as well as a clearer and better conception of its relation to the prosperity of the country as a whole.

Committee: Robert H. Ford (C. R. I. & P.), Chairman; R. N. Begien (C. & O.), W. C. Cushing (Penna.), J. M. R. Fairbairn (C. P. R.), W. D. Faucette (S. A. L.), E. T. Howson *(Railway Age)*, Edwin B. Katte (N. Y. C.), Milo S. Ketchum (U. of Ill.), C. H. Mitchell (U. of Toronto), C. A. Morse (C. R. I. & P.), G. J. Ray (D. L. & W.), Henry E. Riggs (U. of Mich.), H. R. Safford (G. C. L.), W. B. Storey (A. T. & S. F.), Geo. F. Swain (Harvard Univ.), W. G. Raymond (State U. of Iowa).

Discussion

Chairman Ford: A great deal of the work that this committee has done cannot be expressed in type. I think in the course of a year or possibly another year, we will be in a position where the effect of this Association, acting through this committee, can be more definitely shown than perhaps we are able to do in a report today.

The committee has had most whole-hearted co-operation from the colleges. They are asking us what we want in the way of training for men who may go into transportation. The summary seems to be that this committee will go to this Association with some form of a questionnaire, and a sub-committtee of the general committee has been sudying this now for over a year.

The tentative questionnaire which was prepared seemed to meet with some objection from the fact that it seemed difficult. One large western railroad undertook to collect some of the preliminary information. In the doing of it we found that we had gone beyond the province of this Association in that it was not technical education, but rather college training, and when we reached that point we discovered that we had gone into the entire railroad field. Thirty-eight thousand records were examined by one road. It took 208 hours. It was found there that out of 38,000 employes, approximately one and a half per cent were college trained men, as follows: Executive, 8; operating, 361; traffic, 39; law, 13; engineering, 27; real estate and tax, 3; purchasing, 9; financial, 1; telegraph, 3; personnel, 4; surgical, 1, and dining car, 13.

[Mr. Ford then called on E. T. Howson, chairman of the sub-committee, to develop the subject further.]

E. T. Howson (*Railway Age*): The committee holds no brief for college men as such, but is trying to find the facts. It is our belief that the only way to determine the value or lack of value of the man with college training to the railways is to study the experience of those men who have entered railway service and the experience of those railways that have trained college men in their ranks. It is common knowledge that many colleges are openly discouraging men from entering railway service today. It is equally generally known that many industries are making aggressive campaigns to bring college men into their ranks, sending men to universities to look over the graduates, to interview and to select specific men. Your committee felt that impressions would not be on a safe foundation for investigation which might have as far-reaching conclusions as we hope this one will have ultimately. It, therefore, set out to prepare a questionnaire. The form of that questionnaire is still before the sub-committee. It is a new kind of investigation. It must be sufficiently broad to bring out the information which the railways themselves will require if they are to check its conclusions in the application to their own railways. It should not be any more complicated than is necessary to draw out that information. If the committee is to draw conclusions based upon facts, it must of necessity have the co-operation of the members of this Association in the compilation of those facts. If the questionnaire is brought to a form satisfactory to the committee and is sent to your railroads, we solicit the whole-hearted co-operation of the members of this Association in seeing that the information requested is compiled and returned.

Milo S. Ketchum (Univ. of Ill.): The chairman has asked that I outline some of the things that industries are doing to attract college men. Last year we were visited by the representatives of 65 industries. These representatives were men of prominence and ability and in some cases more than one representative came from an industry. For example, this week three representatives of the American Telegraph and Telephone Company are at the University of Illinois interviewing students. Yesterday I had an opportunity to discuss this matter with the chief personnel officer of that organization, and I was very much interested to get his reaction on the value of college trained men to that organization. A few years ago the technically trained man had little advantage over the man who had come up without that training, and it was reasonably fair for the two men to go along together. I was very much interested to learn that a study made by the American Telegraph and Telephone Company indicated that today the technically trained man will reach a position of responsibility in their company six years younger than a man who has not been technically trained, and the indications are that that gap is rapidly widening; it will soon be 10 years. If the railroads find the problem the same as the American Telegraph and Telephone Company, it will not be long until the technically trained man will reach a position of responsibility 10 years earlier than that same man would if he had not had the advantage of that technical training.

It is no use to attract young men into railroad work unless the railroads are prepared to give those men a chance to show what they are good for. Just as soon as that information goes back to the colleges, no amount of pressure on earth that the faculty could exert would keep the men from flocking to the railroad. The men are going where they can find the opportunities and they know better than the rest of us whether the opportunities are there or not. There is no question but what the universities are sympathetic with the problem, the students are sympathetic and they are ready to be shown.

Report on Economics of Railway Operation

The results which have been obtained by the railways during recent years in the handling of heavy traffic with comparatively small increases in facilities is particularly indicative of the value of a close study of train operation. Thus the work of the Committee on Economics of Railway Operation assumes a position of importance. The report this year includes an analysis of the effect of speed upon the cost of transportation, further data on methods for increasing the traffic capacity of a railroad, an analysis of costs as applied to starting and stopping trains and the economy resulting from the operation of trains against the current of traffic. G. D. Brooke has been chairman of the Committee on Economics of Railway Operation for the last three years and a member since 1917.

G. D. Brooke
Chairman

THE COMMITTEE presented reports covering the following subjects: (1) Revision of the Manual in Appendix A; (2) Effect of speed of trains upon the cost of transportation in Appendix B; (3) Methods of increasing the traffic capacity of a railway in Appendix C; (4) Methods of analyzing costs for the solution of special problems, including a study of the costs of starting and stopping trains in Appendix D; (5) The economy resulting from the operation of trains against the current of traffic on multiple track lines in Appendix E; (6) Methods for the determination of proper allowances for maintenance of way expenses due to increased use and increased investment in Appendix F; and a progress report (7) The utilization of locomotives to determine: (a) The percentage of time they should be available to perform actual transportation and (b) Methods for obtaining maximum efficiency while so available in Appendix G.

It recommended that the changes in Appendix A be approved for publication in the Manual; that the conclusions in Appendix B, that the report embodied in Appendix C, and in Appendix D, be received as information; that the report embodied in Appendix E be accepted as information and the conclusion substituted for the matter now in the Manual, as indicated in Appendix A; that the "methods for the determination of proper allowances for maintenance of way expenses due to increased use and increased investment," embodied in Appendix F, be approved for publication in the Manual.

Committee: G. D. Brooke (C. & O.), Chairman; R. T. Scholes (C. B. & Q.), Vice Chairman; E. G. Allen (A. T. & S. F.), G. E. Boyd (Railway Review), F. W. Brown (A. C. L.), J. M. Brown (C. R. I. & P.), J. W. Burt (C. C. C. & St. L.), E. J. Correll (B. & O.), H. C. Crowell (Penna.), J. M. Farrin (I. C.), C. S. Gzowski (C. N. R.), E. T. Howson (*Railway Age*), B. O. Johnson (N. P.), E. E. Kimball (Gen. Elec. Co.), M. F. Mannion (B. & L. F.), F. H. McGuigan, Jr. (Car Mfg. Assoc.), A. H. Ostberg (C. B. & Q.), H. T. Porter (B. & L. E.), J. F. Pringle (C. N. R.), Dean W. G. Raymond (Univ. of Iowa), H. A. Roberts (O. W. & N.), L. S. Rose (P. & E.), Mott Sawyer (C. M. & St. P.), M. C. Selden (C. & O.), V. I. Smart (C. N. R.), M. F. Steinberger (B. & O.), J. E. Teal (C. & O.), H. M. Tremaine (Press Conf. Com.), Barton Wheelwright (C. N. R.), J. L. White (A. C. L.), C. L. Whiting (C. M. & St. P.), C. C. Williams (Univ. of Ill.), Louis Yager (N. P.).

Appendix A—Revision of Manual

Present Form	Proposed Form
Operation of trains against the current of traffic on multiple tracks should receive consideration with other methods whenever congestion, delay or overtime prompt investigation of means of facilitating the movement of traffic or increasing the capacity of a line.	Where the volume and distribution of traffic on a multiple track line are such as to cause delays to trains sufficiently serious to warrant the consideration of means of effecting relief, the operation of trains against the current of traffic is, with suitable protection, recommended as safe and as affording a means of increasing capacity at a small expenditure comparable with the cost of additional facilities sufficient to give relief.

Appendix B—Effect of Speed of Trains upon the Cost of Transportation

The increase in speed of trains contemplated in the following discussion is assumed to be accompanied by a decrease in the tonnage rating as compared with the maximum rating over the division. The discussion of such an increase in speed, therefore, is predicated on a corresponding decrease in the tonnage rating with a resulting increase in the number of trains required to transport a given tonnage of freight.

Maintenance of Way and Structures.—Where the increase of speed involves decreased tonnage rating and consequently a greater number of trains with the corresponding increase in engine mileage, an additional factor is introduced, since the engine mileage is a potent factor in maintenance of way expenses. The exact effect of increased speed when accompanied by decreased rating and a correspondingly greater engine mileage will depend upon the ratio between engine tonnage and freight car tonnage over the division under normal operation. If the locomotive constitutes about 10 per cent of the total tonnage in a train, an increase in speed that would increase the number of trains 15 per cent might be expected to increase the M. of W. and S. expenses allocable to the traffic involved about 1.0 per cent.

Maintenance of Equipment.—The committee has been unable to find any definite data relating to the effect of speed of trains on cost of maintaining equipment. Inas-

much as the increased speed contemplates an increased locomotive mileage to transport a given tonnage of traffic and locomotive maintenance varies largely with the mileage run, increased speed will result in an increase in locomotive repairs almost in proportion to the increase in engine mileage. Moreover, since locomotive repairs constitute about one-fourth of all the expenses affected by speed of operation, this item is of considerable importance. Within the limits of practical operation, the effect of speed of trains on maintenance of freight cars is probably negligible, since the car mileage is not changed by such increase in speed.

Dispatching Trains.—A small increase in the number of trains would require the continuous attendance of operators at small way stations where, with fewer trains, attendance for only part time is sufficient, thus increasing this item to a small degree.

Fuel for Road Locomotives.—The effect of speed of operation on fuel consumption was illustrated in a series of curves taken from Vol. 14 (1922), Proceedings of International Railway Fuel Association, and in another figure, which showed the results of test observations on the three different railroads. Water consumption may be assumed to vary with the fuel consumption.

Lubricants.—The expense would be increased. It is probable that the locomotive lubricant consumption would vary with the increase in speed at least.

Engine House Expenses.—These items would vary with the number of handlings of the locomotive, which, in turn, would vary inversely with the tonnage rating. Therefore, enginehouse expenses might be expected to vary about directly with the speed. If the data are typical, the enginehouse expense may be expected to increase about 1.5 per cent for each m.p.h. increase in average speed within the ordinary operating range.

Road Trainmen.—The effect of speed of operation on wages of train crews indicates that increasing speed of operation has a varied effect on crew wages, depending upon the physical and operating characteristics of the division involved. Train delays seem to bear no definite relation to tonnage rating or speed. The accidental factor of delays renders the results of a few tests relative to the effect of speed on wages uncertain. Fuel and train wages constitute 60 to 70 per cent of all direct train expense, hence these two factors are of prime importance in estimating the effect of speed of operation on transportation costs. (Figures were submitted showing the various relations.)

Fixed Charges.—Where neither the capacity of the track nor the capacity of the available rolling stock is exceeded, the investment in roadway and in equipment will not be increased with any increase in speed.

In the second case, where the capacity of available rolling stock is exceeded by the traffic at hand to be carried, fixed charges may be a factor. If this condition should be permanent, economy would doubtless require the procuring of additional rolling stock. Where the condition is temporary or seasonal, the balancing of higher operating expenses resulting from increased speed of operation to produce greater capacity against the fixed charges on additional rolling stock would be a necessary consideration.

Variation of Transportation Efficiency with Speed.—The transportation efficiency of an engine in ton-miles increases with the speed within the ordinary range of speeds reaching a maximum and then decreasing. Theoretically, the maximum transporting capacity of available rolling stock would result with a rating of the locomotive to secure maximum ton-miles per train hour. However, this theoretical result would be tempered by interference from the additional trains required to transport a given amount of freight and by the fact that locomotives are not actually on the road more than about a third of the time and freight cars are not on the road more than perhaps five per cent of the time.

Only under conditions of traffic congestion when business is lost to the road by lack of capacity to handle is loading to secure the maximum ton-mileage per *train hour* instead of per *train mile* generally justified. In such cases, the loss due to greater cost per ton-mile will be balanced against loss due to loss of business. In such cases, the most economic rating will lie between the maximum tonnage rating and the maximum capacity rating owing to interference of additional trains required to transport a given tonnage.

Appendix C—Method for Increasing the Traffic Capacity of a Railway

The primary object of this committee's work has been to study the effect of various operating conditions upon freight train performance. Thus far the committee has investigated the following: (1) The effect of the number of trains per day; (2) The effect of the length of engine district; (3) The effect of double tracking; and (4) The effect of passenger train operation upon freight train performance.

The effect of two new conditions upon freight train performance was discussed in this year's study, namely: (5) The effect of supervision; and (6) The effect of substituting heavy steam power for light.

The road on which this study was made is about 212 miles long, and is divided into two engine districts, the western section being 96 miles long and the eastern section 116 miles long. Of the traffic handled one-third originates on the line and two-thirds is received from connections. There are two heavy interchange points, one on each section. On account of this and the saw-tooth character of the profile, the operation is more or less complex, that is, the service does not consist of a simple road movement of uniform tonnage. "Set-outs" and "pick-ups" are characteristic of the operation. In other words, the conditions are typical of general cases.

In order to analyze this operating data use is made of the train performance charts discussed in previous reports, together with tonnage record charts.

In all of the studies of this committee it has been assumed that the position and slope of the lines in this train performance and tonnage record are affected by changes in major operating conditions. To test this assumption certain events in the last five years of this railroad's history are indicated in a diagram for gross ton miles. All of the events noted had an effect upon train performance which effects can be classed under two heads, (1) effect of supervision, and (2) effect of substituting heavy steam power for light.

Effect of Supervision

It is ordinarily understood that supervision has to do with those factors affecting the morale, working conditions or direction of the employees. The effect of these factors upon train performance depends to a large extent upon the degree that this function is exercised. It is made manifest only periodically when an extra effort is made to achieve better results or when conditions arise which render it ineffective.

Effect of Substituting Heavy Steam Power for Light

During the latter part of 1923 work was begun on the road to put it in condition for the operation of heavier steam power. This work consisted of renewing several bridges, laying heavier rails, and modifying passing sid-

ings, etc. In May, 1924, this work was far enough along to permit the operation of heavier power.

From the summary of operating statistics for the years 1921 and 1923 certain differences in operation were noted. The class of power used was practically identical, that is, nearly 41 per cent of the total locomotives dispatched were superheated consolidation type engines, referred to as Class B. The Class C locomotives were saturated steam engines consolidation type, about 20 years old.

The tonnage per train (ton-miles per train-mile) for 1923 was 1,259 tons against 1,229 tons for 1922, or 2.3 per cent heavier in 1923 than in 1921. The number of locomotives dispatched per 100 train miles in 1923 was 1.229 against 1.143 for 1921, or in the ratio of 1.074 to 1.

In other words, the operation in 1923 was equivalent to hauling 2.3 per cent heavier trains with 7.4 per cent more locomotives, or it is equivalent to hauling the same weight trains with 5 per cent more locomotives. This slight difference in the method of operation would be expected to show a slight reduction in the average road time. The tonnage record chart showed for the same tonnage handled about 3.2 per cent better average road time. On the train performance chart for the same number of trains there is a reduction of only about 2 per cent in the average road time per train.

The Class A locomotives for 1924 were modern Mikado superheated locomotives. These locomotives were substituted for the old Class C saturated steam consolidation locomotives. In the six-months' period of 1924 the tonnage per train averaged 1,436 against 1,259 for the corresponding period in 1923, or a gain of 14.06 per cent in train weight. The number of locomotives dispatched per 100 train miles decreased 0.9 per cent. In other words, this is equivalent to hauling 14.2 per cent heavier trains with the same number locomotives, some of which are heavier than those used in 1923.

From the train performance curves it was seen that a slight improvement was made in the average road time for the same number of trains per day. Owing to the increased weight of trains the tonnage record chart showed about 18.9 per cent increase in the gross ton miles which can be handled in the same time. As a matter of interest the boiler capacity of the Class A locomotives is about 13 per cent larger than the boiler capacity of the Class B and about one-third greater than the Class C locomotives. On this basis the results are somewhat better than would be expected from the estimated differences in the rating of the locomotives.

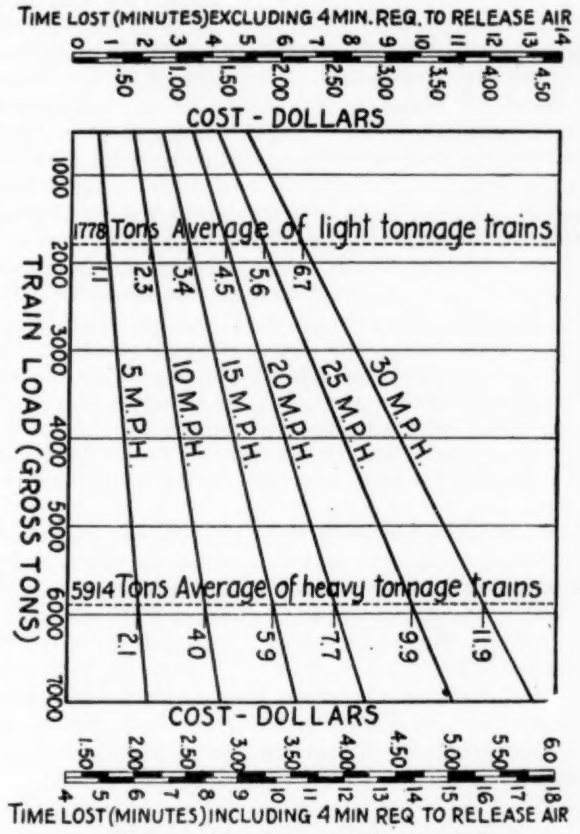
Conclusions

In every study where this method of analysis has been applied, most encouraging results have been obtained. Applications of a far-reaching character can be seen for it as a means of estimating operating expenses as well as pointing out what capital expenditures are required to obtain any desired result.

Appendix D—Methods of Analyzing Costs for the Solution of Special Problems

During February, March and May, 1924, observations were made on a number of through tonnage freight runs for determining such direct cost items as possible. The observations covered trains handled by both Santa Fe and Mallet type locomotives, having a tractive power of 76,100 lb. and 72,600 lb. respectively. The actual gross tonnage handled ranged from 1226 to 5998, and temperature conditions from a low mean 28 deg. F. in February to a high mean of 55 deg. F. in May. A total of 43 observations were made.

The records of these observations were grouped according to type of power, tonnage handled and weather conditions. The largest group, containing nine observations of full tonnage Mallet trains and eight observations of light tonnage Mallet trains operated during May, appeared to be the most satisfactory for developing the solution to this problem.



Curves Showing Net Loss of Time and Cost to Stop and Accelerate Trains

The grades vary from 0.37 per cent ascending to 0.50 per cent descending, and as there are approximately as many ascending grades as descending grades, it will be assumed that the average results are equivalent to what would be obtained if all observations were made on a level grade. The curvature on this line is light and as these stops were at water stations, the major portion of the distance covered between the point of stopping and the point where the former speed was reached was on straight track.

With the data obtained charts were prepared to show the cost of stopping and starting a Mallet through freight train under varying train loads and speeds. The costs shown were presented as information, and, while they may be applicable on the road upon which the tests were conducted, they can not be generally applied. However, it is felt that the method of compilation may be safely used in developing analogous costs on other roads. During the coming year, it is expected to have a large number of additional observations made in order to obtain sufficient experience to prove or disprove the practicability of the method.

Appendix E—The Economy Resulting from the Operation of Trains Against the Current of Traffic on Multiple Track Lines

The operation of trains against the current of traffic implies the diversion of trains to a track which is normally used for movements in the opposite direction but which is temporarily idle, thereby avoiding delay to these or to other trains and expediting their movement thereby. It is, therefore, a step in the more intensive utilization of

a property, avoiding or postponing the expenditure of funds for additional facilities and for additional main or passing tracks otherwise made necessary by delays to trains.

The prevention of undue delays to trains may be avoided by providing additional tracks for use in the direction of congested movement. It may also be overcome in part by the use of the other existing main tracks so far as they are or can be readily made idle for the movement of trains in the direction of preponderant traffic, separating the slow and the fast and allowing each to proceed without interfering with the other. In some instances where the traffic is uniformly heavier in one direction between certain hours and then in the other direction for other periods, as in suburban zones, the direction of traffic on one or more tracks may be reversed by standing timetable order to meet this condition. Thus, a third track is frequently used regularly for inbound trains in the morning and outbound in the evening. This, because of its regularity, does not come within the scope of the committee's report, for its assignment refers to the diversion of trains against the current of traffic at will and without advance warning or notice in order to meet conditions as they may arise at any time throughout the day.

From the information received in reply to its questionnaire three years ago, it was evident to the committee that two roads have followed this practice more generally and for a longer time than others. These roads are the Chicago, Burlington & Quincy and the Cleveland, Cincinnati, Chicago & St. Louis. The committee concentrated its attention, therefore, on a study of the methods in force and the results secured on these roads, going over representative divisions of both and observing the manner in which the trains were diverted on each.

Objections to This System

Some objections are raised to this practice, among which are the following:

(1) It is claimed that after train crews and other employees have become accustomed to the operation of trains in one direction only on a track, the running of trains in the other direction introduces a special hazard. In reply it may be said that while this objection may be valid for a short time following the initial introduction of this practice, it is merely a result of habit and can be overcome quickly. The actual operation of trains against the current is identical with that prevailing on a single-track railway, the typical railway of this country, and the hazard should be no greater. Furthermore, no road hesitates to operate trains against the current of traffic in emergencies, and such operation as a customary practice really removes the hazard attendant on the operation in cases of emergency.

(2) That it leads to the introduction of facing point switches in main tracks. This may or may not be true, for the operation of trains against the current of traffic reduces the necessity for additional passing tracks and the switches therefor. Furthermore, the same hazard exists at every switch in a single-track main line. Frequent use of these crossover switches also leads to their maintenance to higher standards than for normal operation in one direction.

(3) That it introduces a hazard for trackmen and other employees on track. This is not valid, for while a hazard may be introduced when this practice is resorted to only in emergency, when it becomes usual the danger can be overcome by the exercise of proper precautions.

(4) That it requires an additional investment if the maximum advantage is to be obtained. This is not necessarily true, for trains may be reversed over existing crossovers. After this, added investment can be regulated by the demands, as is illustrated by the practice on the Burlington and the Big Four of lining up crossovers for reverse movement by hand at many points, adding interlocking plants only where the traffic warrants and affording complete automatic signal protection for reverse as well as direct movement on lines of still greater density of traffic. Where the number of movements to be made against the current is small, the investment can be confined to facing point crossovers or trains can be backed through existing trailing crossovers. Beyond that point it should be increased only as an adequate return can be earned.

Advantages of This System

The advantages of this system are:

(1) That it keeps trains moving, thereby reducing delays and the overtime resulting therefrom and in many cases eliminates the necessity for tying up trains in compliance with the 16-hr. law. A study of the train sheets of 201 trains moved on a typical day on those sections of the Big Four in which trains are diverted against the current of traffic when necessary showed that five trains were prevented from being tied up under the 16-hour law, while 1,880 minutes were saved in the time required for trains to complete their runs between terminals. If, for example, this delay is computed on the basis of 40 cents per minute, this saving in time alone aggregates $752 for the day, or at the rate of approximately $275,000 per year in the territory on which this study was based. The elimination of stops also reduces the number of drawbars pulled out, etc.

(2) That it increases the utilization of locomotives and cars by facilitating their movement over the road, thereby increasing the miles per car day, reducing per diem, etc.

(3) That it increases the capacity of a line by enabling more trains to be moved, thereby postponing the necessity of making considerable expenditures for additional main tracks to handle a given volume of traffic without excessive delays. It is estimated that it would be necessary for the Burlington to construct a third track for a large part of the distance between Aurora and Galesburg to handle the present traffic if this practice were now abandoned.

(4) That it reduces the necessity for passing track facilities to the minimum. This is particularly evident on the Burlington where only 15 passing tracks of sufficient length to accommodate a tonnage train are provided on the 126 miles between Aurora and Galesburg, and the observation of the Committee was that a large part of these are seldom used.

(5) That it facilitates the conduct of heavy maintenance operations, such as the laying of steel and reballasting, by facilitating the diversion from all traffic from the main track on which such work is being handled by the operation of the remaining track as a single track during the working day. The Burlington utilizes this method of train operation to enable the maintenance of way forces to lay practically all of their rail with rail-laying machines with the exclusive use of their track. Work trains are also enabled to distribute and take up rail, unload ballast, etc., without interference from regular traffic.

(For conclusion and recommendation see Appendix A.)

Appendix F—Method for the Determination of Proper Allowances for Maintenance of Way Expenses Due to Increased Use and Increased Investment

Maintenance of a property is composed of properly related material and labor units ultimately expressed in total money expenditures. The normal requirement or expenditure established for any base period is therefore subject to adjustment for differences in the cost levels of the base period and the period in which performances are to be compared. Data and bases for such cost adjustments are available from the studies made by all railways of their performances during the three years ended June 30, 1917.

A complete solution of the problem assigned the committee therefore involves the following procedures:

(A) Establish a base period of normal maintenance expenditures for the property.

(B) Develop factors for and adjust base period expenditures to cost levels of the comparison period.

(C) Develop factors for differences in the amount of property to be maintained in the base and comparison periods. Application of these factors to base period expense adjusted for cost gives the maintenance allowance for comparison period property, but subject to adjustment for possible differences in use.

(D) Develop factors for difference in use in the base and comparison periods. Application of these factors to base period expense adjusted for cost and property gives the proper maintenance allowance for the comparison period.

Allowances for Increased Investment

Increases in investment are the net changes in capital

account resulting from physical changes in a property. It is apparent that increased investment is not a direct or proper measure of increased maintenance requirements. These requirements can be developed only from consideration of the property units actually represented by increases in investment in fixed property which for present purposes may be classified as follows: (A) Way, including items chargeable to roadbed and track accounts; and (B) Structures, including bridges and buildings and the miscellaneous items not otherwise classified.

Way, that is roadbed and track, is responsible for about three-fourths of the total cost of maintaining fixed property and generally absorbs the major portion of investments for increases in the railroad plant either through extensions of road or increases in capacity of existing property.

Changes in the amount and character of Way represented by increases in investment are readily measured in track miles. In order to determine the added maintenance requirement, the different classes of trackage involved should be expressed in terms of equivalent main track by means of the equated track mile plan. Where the data are available this plan may be extended to include less important track items and thus tend to develop more accurate results.

Investments—Structures

The accounts in this general group are of such a nature that a physical comparison is virtually impossible. The cost of maintaining a dollar's worth of property can readily be obtained with reasonable accuracy, but the result obtained by multiplying this unit cost by the increase in investment is generally so approximate as to be worthless.

In view of the foregoing, it is our recommendation that the estimated cost of reproduction new, as indicated in the underlying engineering reports of the Interstate Commerce Commission, prepared in connection with the federal valuation, be used for this purpose in lieu of the so-called investment account. Although the inventories vary with the valuation dates of respective carriers, these reproduction estimates are in all cases priced as of 1914.

Adjustment must be made for the difference in price level between 1914 and the period of normal maintenance selected as the base period, and reproduction cost of the fixed property maintained as of valuation date must be adjusted for additions and deletions that occurred between valuation date and the base period. The relationship between the reproduction cost of base period property and maintenance expenses may then be determined.

Allowances for Increased Use

It is well recognized that the cost of maintenance of way and structures becomes greater with increased use of or traffic handled over a railway and that the converse also is true. The relation of use and maintenance expense is incapable of exact determination, but can be approximated within limits sufficiently accurate for practical purposes in studying properties as a whole. In general, every railroad produces transportation units in the two quite distinct classes of freight and passenger service. Since no common transportation unit can adequately cover both, it is necessary to combine and measure the effect through a suitable equated unit.

The "Use" unit should be related in some definite way to the two classes of traffic, which are in general distinguished by the two principal characteristics of weight and speed, which directly influence maintenance requirements.

There seems to be good reason for selecting the freight gross ton as the basis in the equation scheme on account of its general availability, its relatively large proportion of the weight element on most railroads, and the further general similarity of gross tons. Gross tons of freight cars are, therefore, taken as unity; freight-locomotive-tons are given a factor of two; passenger-locomotive-tons a factor of three; and passenger-car-tons, a factor of one. The factor of one for passenger-car-tons is in recognition of the fact that higher standards of equipment construction, and the better maintenance of passenger equipment over that of the freight cars, tends to mitigate the damage resulting from a higher speed, as well as the special requirements demanded thereby. Trials which have been made from time to time on various typical railroads indicate that the allocation of "use" units as between freight and passenger service, seem to give a reasonable expression of the maintenance that should be charged against these two services.

[The report was submitted by G. D. Brooke, chairman. The recommendations of the committee were adopted without discussion and the committee was dismissed with the thanks of the Association.]

Hold Memorial Service for Deceased Members

At the close of the morning's session yesterday the convention paused in the conduct of its business to honor the memory of two of its members who had died during the past year, A. W. Johnston, a past president, and H. T. Douglas, Jr., who was a director at the time of his death.

G. H. Tinker (N. Y., C. & St. L.): My acquaintance with A. W. Johnston was during the last 20 years of his life. That was long enough for me to learn that he was a man who was a friend to all of the employees on his road, and that he had the friendship of all the employees on the road. Those who were members of this Association during its earlier years will recall the great interest Mr. Johnston had in the work. When the Association undertook to make some impact tests to determine the impact upon steel bridges, Mr. Johnston was one of the first to co-operate through the Nickel Plate road by furnishing facilities, the bridge and engines, and the assistance to make these tests. I think you will find the first series of tests were made upon a bridge on the Nickel Plate. The Association owes a great deal to the fact that it had men of the character of Mr. Johnston during its earlier years.

A. C. Irwin (Portland Cement Association): The ability of Mr. Johnston to carry the complete picture of everything that was going on on the railroad was marvelous. It soon became known among the employees to the very last man that Mr. Johnston knew just what he was doing. It also became known among all of us that not only did Mr. Johnston know what we were doing, but that he was sympathetic; he understood our problems, and they were his problems.

R. A. Cook (C. & A.): The privilege has been mine of being associated closely with our late director, Mr. Douglas, during the last 12 years of his life. He first impressed me by his knowledge of and insight to the profession and by his unusual energy. Important decisions were rendered promptly and all his business duties were executed with an earnestness and energy which seemed to leave his personal comfort entirely out of consideration. No man could be more earnestly devoted than Mr. Douglas was to the interests of his employees and to such other interests as he espoused. I desire to pay tribute, however, not so much to Mr. Douglas, my superior officer, as to Mr. Douglas, my friend, for he has been my

sincere and highly esteemed friend since I first became well acquainted with him. He was a man of the most gentlemanly and courteous nature, one who ever had the highest ideals, and whose loyalty to these ideals and to the principles in which he believed was unswerving. By his death, thils Association has lost a most loyal supporter and earnest worker. His long membership in it was a source of pride to him.

Mr. W. G. Bierd (president of the C. & A.): This is a privilege most highly esteemed to speak of and pay my respects to one of your members, Mr. Douglas. He was my friend, a most favored friend. I shall cherish his memory and his friendship during the remainder of my life and shall be a better man myself because of having known him and having had his friendship. I have known Mr. Douglas for 15 years and was associated directly with him in our railroad work for 10 continuous years. In this time I had ample opportunity to know him well and to know his worth and character as a man, and I can use no words more fitting than to say that in every respect he proved himself a true and loyal friend to his associates in life and a true and devoted officer to the company and the superiors whom he served. In an organization such as our railroads have, the head or principal officer relies upon his subordinate officers and the subordinates become extremely valuable to the success of the organization, or otherwise. As a perfectly natural sequence, that most usually we cannot entirely define or give the reason for, because we do not intend it to be so, we purposely treat all of our subordinates alike. Yet the fact remains that the head of such an organization becomes closer to some than he does to others of his assistants. There is that something that draws a man to another, and the associations become very close. We grow to rely upon and trust implicitly such men. These were the relations between Mr. Douglas and myself. In many respects I favored him, indeed loved and admired him, beyond all others in our organization. Like all of us, Mr. Douglas had his faults, his weaknesses, but as men go his faults and weaknesses were few, and having proved this faithful and ever-expressed disposition in him I learned to rely upon him almost implicitly. There are but few men who at some time in their business struggles do not criticise or say things that are not altogether becoming. I can, however, with great pleasure and with great personal pride, say that I never heard Mr. Douglas speak an unfair word or do an unfair act to any man with whom he was associated, although knowing well that these associates were not always as fair and honorable to him. When the day's work was done it was then that Mr. Douglas shone most brightly. It was then that I realized that it was he and not myself that was the superior. Mr. Douglas was a profound student. He possessed educational qualifications that I never knew in any other man. This knowledge was far-reaching. He was as familiar with the arts and sciences as he was with his daily work. He was a lover and master of history. He was a connoisseur of the drama, paintings, and music. He quoted the best of the authors verbatim. From all of these his disposition and character were shown, because he retained the finer things, the finer expressions, the finer writings and sayings from all of these great authors, scientists and artists. All of this was reflected in this refined gentleman, because always and under all circumstances was Mr. Douglas a gentleman.

[W. M. Camp (*Railway Review*), J. L. Campbell (S. P.), and Edwin F. Wendt (Washington, D. C.), also spoke of their acquaintance of Mr. Douglas, space limitations necessitating omitting their remarks here.]

Mr. Johnston was a charter member of the association and his election to the presidency came after two years as vice-president and three years as director. His death on September 8, 1924, occurred about three years after his retirement from a long period of active railway service, his last position being that of assistant to the president and general manager of the New York, Chicago & St. Louis. Mr. Johnston was born at Boston, Mass., on March 4, 1854, and received his technical education at Massachusetts Institute of Technology. He entered railway service in July, 1875, as a clerk in the general superintendent's office of the Pittsburgh, Cincinnati & St. Louis and he served as a clerk and a draftsman on that road until December, 1878, when he became assistant engineer. On January 1, 1882, he became chief engineer of the Toledo, Delphos & Burlington, in which capacity he served until April of the same year, when he became superintendent of the Leavenworth, Topeka & Southwestern. He entered the service of the New York, Chicago & St. Louis in April, 1884, as a division engineer and five years later was promoted to superintendent of the Eastern division. Thereafter he served successively as general superintendent and general manager and assistant to the president.

A. W. Johnston

Mr. Douglas had been chief engineer of the Chicago & Alton for a period of 12 years when his death came after a short illness only a few days following the last convention. Mr. Douglas was born on June 16, 1863, in Richmond county, Va., and entered railway service in 1880 as a rodman on the Georgia Pacific, now a part of the Southern. In 1881 he was employed by the Baltimore & Ohio as an instrumentman and was subsequently promoted to assistant resident engineer and resident engineer on the Philadelphia division. He entered the service of the Mobile & Ohio in 1887 as division engineer and in 1889 became locating engineer and resident engineer on the Seaboard Air Line. He was appointed chief engineer of the Ohio & Southern in 1893 and in 1894 was appointed locating engineer of the Virginia, Fredericksburg & Western. Then followed two years' service in the war department as an assistant engineer in charge of harbor and marine coast defense work. He was appointed chief engineer of the Pittsburgh & West Virginia in 1899 and held this position until 1901, when he was appointed chief engineer of the West Side Belt railroad. In 1904 he became chief engineer of the Wheeling & Lake Erie, a position he held until 1912, when he was called to the Chicago & Alton to occupy the position of chief engineer.

H. T. Douglas, Jr.

A. R. E. A. Elects New Officers

Results announced at close of Wednesday afternoon session—J. M. R. Fairbairn selected for President

PRIOR to the adjournment of the afternoon's session yesterday, President Ray called upon Secretary Fritch to present the report of the tellers on the election of officers of the association for the ensuing year, as follows:

President, J. M. R. Fairbairn.

Second Vice-President, D. J. Brumley.

Treasurer, George H. Bremmer, re-elected.

Secretary, E. H. Fritch, re-elected.

Directors, G. D. Brooke, W. H. Kirkbride and C. E. Johnston.

Nominating Committee, W. R. Armstrong, T. T. Irving, H. E. Hale, A. F. Dorley, A. Montzheimer.

In addition, C. F. W. Felt, second vice-president, automatically becomes first vice-president.

J. M. R. Fairbairn, President of the A. R. E. A.

In the election of J. M. R. Fairbairn to the presidency, the American Railway Engineering Association secures for the coming year an executive engineer of marked ability for its presiding officer. In addition the Canadian members are given the satisfaction of having a man at the head of the Association who is distinctly one of their own. Canadian railway men have always been active in the affairs of this organization and in recognition of this fact that country has always had representation on the Board of Direction and periodical representation in the highest office of the Association.

In this connection it is interesting to note that over a rather long period of years Mr. Fairbairn has been the only engineer so chosen who was not only born and raised in Canada, but who also acquired his education and engineering experience in that country, and chiefly with the Canadian Pacific. It is also interesting to note that the last president from north of the boundary (1917) was also from the Canadian Pacific, being John G. Sullivan, then chief engineer of the Lines West. Mr. Sullivan was not, however, a native of Canada. Presumably the nominating committee had in mind the two-fold opportunity of securing an excellent engineer as the Association's executive officer and of giving Canada another turn at the helm when it nominated H. R. Safford as second vice-president in 1918. Before ascending to the presidency, however, he returned to the States, where he had been born and where he had spent the greater part of his life.

In addition to being distinctly a product of Canada, Mr. Fairbairn is of the type that believes that Canada is Canada and as Canada it must make its way, and because of that, paradoxical as it may seem to some, he is exceedingly cosmopolitan in his views, his beliefs and his actions, and is always quick in his appreciation of progress no matter where it may first appear. In these and through these traits of character, he is unconsciously a far better exponent of the common aims, thoughts, hopes and ambitions of the United States and Canada, than most of the men in public eye who speak so feelingly of our sister nation to the north or our sister nation to the south, depending on which side of the border they may be from. Although somewhat inclined to be a little reserved in his demeanor, he is nevertheless a most human type of man possessed of qualities that make friends for him quickly, and when once made, bind them to him closely. In his relations with his friends and associates in the engineering field and out of it, as well as in the conduct of his work as chief engineer, ranging from the mere matter of arranging for a luncheon to the completion of a large bridge, there is always present that quality of a thing well done and completed in all its details. There is nothing of the superficial in him. In the words of one of his subordinates, he is a "particularly able and popular railway officer."

C. F. W. Felt
First Vice-President

J. M. R. Fairbairn
President

D. J. Brumley
Second Vice-President

He has always taken a great interest in, and has done a considerable amount of work in connection with engineering societies. He is, for instance, a member of the Institute of Civil Engineers of England, a past-president of the Engineering Institute of Canada, and a mem-

ber of the Canadian Engineering Standards Association and the American Society of Civil Engineers in addition to his active participation in the affairs of the American Railway Engineering Association during past years. In his work with the latter association, he was a member of the Committee on Track from 1911 to 1915, a member of the Committee on Rail from 1916 to date and served as vice-chairman from 1921 to 1923, inclusive, a member of the Committee on Standardization since 1919 and a member of the Committee on Cooperative Relations with Universities for the past two years. He was elected a director in 1920, second vice-president in 1923, first vice-president in 1924 and now president.

As chief engineer of the Canadian Pacific System, Mr. Fairbairn has a wider scope of activities than is found on most other roads of that or this country, since this road has many interests over and above that of the average road, indicative of which is the string of large hotels which it operates throughout Canada. The engineer of buildings who has formerly been in charge of hotel, office building and large station construction, and worked more or less independently, has recently been taken into the chief engineer's office.

Mr. Fairbairn was born at Peterborough, Ont., on June 30, 1873, and studied civil engineering at the School of Practical Science in Toronto. His summer vacations were largely spent on engineering work with the Canadian Pacific. Following his graduation in 1893, he was employed in various engineering capacities with the Departments of the Interior, of Railways and Canals and of Militia and Defense after which, for a short period, he was engineer in charge of construction of the Lachine and St. Laurent lines of the Montreal Park & Island Railway. This was followed by work of a different nature in that he became engaged in mining claim, land grant and other surveys for mining properties in British Columbia, during a part of which time he acted as city engineer of Kalso, B. C. In the early part of 1898, he entered private practice as a civil and mining engineer and provincial land surveyor in British Columbia. He continued this work for about two years and in April, 1900, entered the employ of the Canadian Pacific, leaving this work for a period of about one year between August, 1900, and August, 1901, to accept a position as engineer in charge of one section of the Trent Canal under the Department of Railways and Canals. On return to the railroad he was appointed assistant to the division engineer. His service since that time has been continuous with the Canadian Pacific and he was subsequently promoted to resident engineer, assistant engineer, and division engineer up to 1908 when his ability was more clearly recognized and he was promoted to principal assistant engineer, followed by promotions to engineer maintenance of way in 1910 and assistant chief engineer in 1911. On July 1, 1918, he was again promoted, this time to chief engineer of the entire system.

American Railway Engineering Association Registration

A TOTAL of 209 members and 70 guests registered at the convention yesterday, bringing the total registration of members for the two days to 750 and the guests to 192 or a combined total of 942. This compares with a total registration of 950 for the first two days of last year. The registration follows.

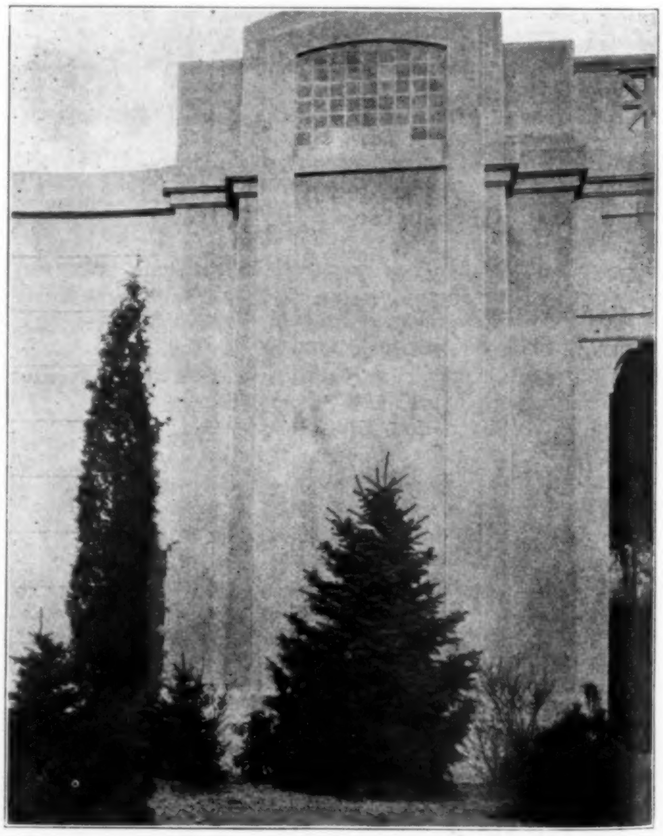
Adamson, G. J., div. engr., U. P., Green River, Wyo.
Alfred, F. H., pres. and gen. mgr., P. M., Detroit, Mich.
Andrews, J. T., asst. engr., B. & O., Baltimore, Md.
Anthony, F. D., construction engineer, Delaware & Hudson Co., Albany, N. Y.
Baker, William E., supervisor, Pennsylvania, Cleveland, O.
Baldwin, R. A., dist. engr. construction, C. N. R., Toronto, Ont., Can.
Barr, W. M., consulting chemist, U. P., Omaha, Neb.
Barrett, P. T., office engr., C. & W. I., Chicago.
Batchellor, F. D., div. engr., B. & O., Garrett, Ind.
Bates, F. E., bridge engineer, M. P., St. Louis, Mo.
Bartlett, Calvin, real estate agent, Wabash, St. Louis, Mo.
Bayer, E. J., engr. M. of W., P. & E., Indianapolis, Ind.
Beach, D. P., div. engr., Pennsylvania, Indianapolis, Ind.
Beard, M. H., asst. div. engr., B. & O., Akron, O.
Bennett, W. R., div. engr., Wabash, Springfield, Ill.
Bertram, H. A., asst. engr., C. & O. of I., Peru, Ind.
Boots, E. W., engr. M. of W., P. & L. E., Pittsburgh, Pa.
Bousfield, J. C., asst. engr., Wabash, St Louis, Mo.
Braden, E. V., Engr., P., C. & Y., Pittsburgh, Pa.
Breed, Chas. W., office engineer, C., B. & Q., Chicago.
Brooke, G. D., asst. to v.-p., C. & O., Richmond, Va.
Brum, G. M., engr. dept., C., R. I. & P., El Reno, Okla.
Buck, J. A., supervisor, Wabash, Forrest, Ill.
Burnett, W. S., engineer of construction, C., C., C. & St. L., Indianapolis, Ind.
Burrage, W. H., pilot, valuation department, N. Y., C. & St. L., Cleveland, O.
Carpenter, Wm., general foreman in charge track maintenance, B. & O., Chicago.
Carrick, O. W., water engineer, Wabash, Decatur, Ill.
Causey, W. B., city manager, Norfolk, Va.
Chinn, Armstrong, div. engr., Q., O. & K. C., Kansas City, Mo.
Chipman, Paul, valuation and office engineer, P. M., Detroit, Mich.
Clarke, H. R., gen. insp. perm. way and struc., C., B. & Q., Chicago.
Clarke, H. S., engr. main. of way, D. & H., Albany, N. Y.
Colladay, W. E., asst. engr., I. C., Chicago.
Connor, E. H., ch. engr., Missouri Valley Bridge & Iron Co., Leavenworth, Kansas.
Cooper, S. B., ry. engr., Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.
Correll, E. J., div. engr., C. & O., Richmond, Va.
Craine, Arthur, dist. engr., C., B. & Q., St. Louis, Mo.
Crowell, F. N., asst. div. engr., Pennsylvania, Louisville, Ky.
Crumpton, Arthur, val. engr., Can. Natl., Toronto, Ont., Can.
Curtiss, L. B., asst. engr., N. P., St. Paul, Minn.
Dalton, H. G., asst. engr. bldgs., C., B. & Q., Chicago.
Davis, M. B., supervisor, I. C., Newton, Ill.
Davis, B. V., div. engr., C. & O., Peru, Ind.
Dennis, Walt, supt., N. J., I. & I., South Bend, Ind.
Dickerson, B. S., engr. main. of way, E., I. & T. H., Washington, Ind.
Dobson, J. F., asst. engr., B. & O., Baltimore, Md.
Dorley, A. F., dist. engr. M. of W., M. P., St. Louis, Mo.
Doyle, T. L., div. engr., Pennsylvania, Grand Rapids, Mich.
Elliott, Leigh B., engr. main. of way, C., C., C. & St. L., Springfield, O.
Engle, C. W., engr. main. of way, C., C., C. & St. L., Wabash, Ind.
Fair, J. M., supervisor, P. R. S., Chambersburg, Pa.
Fanning, J. E., dist. engr., I. C., Waterloo, Iowa.
Farlow, G. B., asst. engr., B. & O., Western Lines, Pittsburgh, Pa.
Farrin, J. M., asst. engr., I. C., Chicago.
Fithian, E. B., dist. engr., M. P., Kansas City, Mo.
Fox, J. W., right-of-way engineer, F. E. C., St. Augustine, Fla.
Gaines, R. H., engr. M. of W., T. & P., Dallas, Texas.
Gatlin, T. H., B. F. Johnson & Co., Baltimore, Md.
Gersbach, Otto, ch. engr., C. J., Chicago.
Grandy, A. L., asst. to pres. and gen. mgr., P. M., Detroit, Mich.
Guignon, W. E., div. engr., Pennsylvania, Pittsburgh, Pa.
Guild, W. A., asst. supt., A., T. & S. F., Chillicothe, Ill.
Haff, F. W., instrumentman, C., B. & Q., Centralia, Ill.
Hale, H. E., group engineer, Presidents' Conference Committee, New York City.
Hales, F. S., engr. of track, N. Y., C & St. L., Cleveland, O.
Hammond, A. J., 606 South Michigan Blvd., Chicago.
Hamilton, Paul, asst. ch. engr., C., C., C. & St. L., Cincinnati, O.
Harrington, J. L., consulting engineer, Kansas City, Mo.
Harris, W. J., div. engr., C., B. & Q., LaCrosse, Wis.
Harrison, E. A., architect, A., T. & S. F., Chicago.
Harvey, W. C., valuation engineer, C. G. W., Chicago.
Hatt, W. K., professor of civil engineering, Purdue University, Lafayette, Ind.

Hawthorne, F. M., div. engr., Pennsylvania, Terre Haute, Ind.
Hayes, H. C., assistant roadmaster, I. C., Champaign, Ill.
Hayes, V. R., asst. engr., Wabash, Springfield, Ill.
Heaman, J. A., ch. engr., G. T. W., Detroit, Mich.
Heimerdinger, W. E., office engineer, C., R. I. & P., Des Moines, Ia.
Heritage, C. S., engr., Washington Terminal Co., Washington, D. C.
Herth, C. E., div. engr., B. & O., Chillicothe, O.
Hewes, John Jr., asst. supt., B. & O., Akron, O.
Hillman, F W., div. engr., C. & N. W., Chicago.
Hinchman, C. F., engr. main. of way, C., C., C. & St. L., Mt. Carmel, Ill.
Hoagland, J. R., val. engr., C. & A., Chicago.
Hobbs, W. H., engineer of design, M. P., St. Louis, Mo.
Hockman, H. M., first asst. engr., N. Y., C. & St. L., Frankfort, Ind.
Hodge, W. B., engr. main. of way, C., C., C. & St. L., Indianapolis, Ind.
Hood, J. M., gen. supt., A., C. & Y., Akron, O.
Hoyt, C. B., N. Y., C. & St. L., Belliom, O.
Hudson, W. D., civil engineer, 5035 Maple Ave., St. Louis, Mo.
Huntsman, F. C., div. engr., Wabash, St. Louis, Mo.
Huntsman, H. N., div. engr., Wabash, Moberly, Mo.
Jabinsky, Louis, asst. engr., C., C., C. & St. L., Indianapolis, Ind.
Jacobs, R. H., div. engr., Transit Commission, 49 Lafayette St., New York City.
Johnson, F. N., first asst. engr., C., C., C. & St. L., Indianapolis, Ind.
Johnson, J. E., div. engr., P. M., Saginaw, Mich.
Johnson, Maro, asst. engr., I. C., Chicago.
Johnston, D. B., div. engr., Pennsylvania, Louisville, Ky.
Jonah, F. G., asst. to pres. and ch. engr., St. L.-S. F., St. Louis, Mo.
Jones, A. R., div. engr., N. Y. C., Watertown, N. Y.
Jordan, S. A., engr. main. of way, B. & O., Western Lines, Cincinnati, O.
Kelley, H. O., gen. mgr., T. & W., Sylvania, O.
Keough, R. E., asst. engr. main. of way, C. P., Montreal Can.
Kern, J. W., Jr., dist. engr., I. C., New Orleans, La.
Ketchum, M. S., dean, college of engineering, University of Illinois, Urbana, Ill.
Khuen, Richard, gen. mgr. of erection, American Bridge Co., Pittsburgh, Pa.
King. E. E., professor of railway civil engineering, University of Illinois, Urbana, Ill.
Kissell, J. E., engr. main. of way, C., C., C. & St. L., Galion, Ohio.
Lahmer, J. A., senior asst. engr., M. P., St. Louis, Mo.
Lane, E. G., engr. main. of way, B. & O., Baltimore, Md.
Lang, P. G., Jr., engineer bridges, B. & O., Baltimore, Md.
Larsen, Albert, 486 24th Ave., Milwaukee, Wis.
Lawson, W. W., manager treating plants, National Lumber & Creosoting Co., Kansas City, Mo.
Lewis, C. M., div. engr., Erie, Susquehanna, Pa.
Long, R. P., asst. engr., Wabash, Moberly, Mo.
Longshore, R. L., div. engr., Wabash, Montpelier, O.
Loweth, C. F., ch. engr., C., M. & St. P., Chicago.
Mack, W. C., chief draftsman, C., R. I. & P., Chicago.
Macomb, J. deN., office engr., A., T. & S. F., Chicago.
Maischaider, A. F., asst. to gen. mgr., C., C., C. & St. L., Cincinnati, O.
Mannion, M. F., statistician, B. & L. E., Greenville, Pa.
Manson, E. F., div. engr., C., R. I. & P., Trenton, Mo.
Martin, L. B., gen. supt., Illinois Traction System, Springfield, Ill.
McGavren, S. A., asst. engr., I. C., Western Springs, Ill.
McFetridge, W. S., prin. asst. engr., B. & L. E., Greenville, Pa.
McNally, J. F., asst. supt., A., T. & S. F., Emporia, Kan.
Melton, J. K., official photographer, I. C., Chicago.
Metcalf, E. W., acct. engr., M.-K.-T., St. Louis, Mo.
Miesse, W. H., resident engineer, C., C., C. & St. L., Cincinnati, O.
Miller, A. A., engr. main. of way, M. P., St. Louis, Mo.
Miller, J. L., engineer of bridges, N. Y. C., east of Buffalo, Yonkers, N. Y.
Montgomery, C. R., office engineer, M.-K.-T., St. Louis, Mo.
Moore, W. S., engr. main. of way, L., H. & St. L., Louisville, Ky.
Morgan, M. B., dist. engr., Y. & M. V., Memphis, Tenn.
Mullen, Joseph, pres., Arkansas Preservative Co., St. Louis, Mo.
Nauman, F. D., div. engr., O. S. L., Pocatello, Idaho.
Newell, A. B., Pres. and gen. mgr., T. T., Toledo, Ohio.
Nicholson, C. H., Mgr., steamships and car ferries, C. N., Toronto, Ont., Can.
Nuelle, J. H., v.-p., N. Y., O. & W., Middletown, N. Y.
Passel, H. F., ch. engr., C., I. & W., Indianapolis, Ind.
Paulsen, F. C., div. engr., U. P., Cheyenne, Wyo.
Pendleton, D. E., asst. engr., C. & W. I., Chicago.
Petersen, W. H., engr. maint. of way, C. R. I. & P., Des Moines, Iowa.
Pilcher, H. B., Jr., asst. engr., Wabash, Montpelier, Ohio.
Porter, H. T., ch. engr., B. & L. E., Greenville, Pa.
Pringle, J. F., trans. engr., C. N., Montreal, Que., Can.
Purdy, J. W., asst. div. engr., B. & O., Garrett, Ind.
Pyle, H. W., instm., C. R. I. & P., Little Rock, Ark.
Radspinner, W. A., special engineer, C. & O., Richmond, Va.
Rawlings, J. H., asst. engr., M. P., St. Louis, Mo.
Ray, A. L., asst. engr., G. T. W., Durand, Mich.
Ray, G. J. (pres.), ch. engr., D., L. & W., Hoboken, N. J.
Ray, W. M., ch. engr., B. & O., Pittsburgh, Pa.
Reece, A. N., ch. engr., K. C. S., Kansas City, Mo.
Ridge, Reginald, field engineer, B. & L. E., Greenville, Pa.
Riggs, H. E., professor of civil engineering, University of Michigan, Ann Arbor, Mich.
Ringer Frank, ch. engr., M.-K.-T., St. Louis, Mo.
Robinson, J. S., div. engr., C. & N. W., Chicago.
Roller, W. L., asst. engr., H. V., Columbus, Ohio.
Roscoe, H. L., Chemist, K. C. S., Pittsburgh, Kan.
Rozzelle, C. E., asst. div. engr., B. & O., Newark, O.
Sample, C. S., engr. cons., Mo. Pac., St. Louis, Mo.
Schmidt, E. C., professor of railway engineering, University of Illinois, Urbana, Ill.
Sessions, O. H., general roadmaster, D. & T. S. L., Monroe, Mich.
Sexton, J. R., care H. H. Robertson Co., 914 Straus Bldg., Chicago.
Shaver, A. G., consulting electrical and signal engineer, 310 South Michigan Ave., Chicago.
Shaw, W. J., Jr., div. engr., M. C., St. Thomas, Ont., Can.
Sheldon, Chas. S., engr. bridges and struc., Pere Marquette, Detroit, Mich.
Shenefield, W. D., res. engr., I. C., Mattoon, Ill.
Shepard, H. M., assistant chief draftsman, Erie, New York City.
Skov, L. W., off. engr., bridge dept., C., B. & Q., Chicago.
Sloggett, L. O., field engr., C. T. I., I. C., Chicago.
Smart, V. I., special engineer, C. N., Montreal, Can.
Smith, C. E., consulting engineer, Railway Exchange, St. Louis, Mo.
Snyder, J. A., div. engr., M. C., Detroit, Mich.
Sprague, Willson, div. engr., N. Y., C. & St. L., Conneaut, O.
Stelle, C. A., resident engineer, C. & A., Chicago.
Stokley, R. B., asst. engr. main. of way, C., C., C. & St. L.,
Stone, F. A., asst. engr., I. C., Chicago.
Stradling, D. W., valuation engineer, D., T. & I., Detroit, Mich.
Stradling, E. G., superintendent of telegraph and signals, C., I. & L., Lafayette, Ind.
Taylor, Edwy L., cont. agt., N. Y., N. H. & H., New Haven, Conn.
Taylor, J. J., superintendent bridges and buildings, K. C. S., Texarkana, Texas.
Teal, J. E., special engineer operation, C. & O., Richmond, Va.
Temple, E. B., asst. ch. engr., Pennsylvania, Philadelphia, Pa.
Turneaure, F. E., dean college of engineering, University of Wisconsin, Madison, Wis.

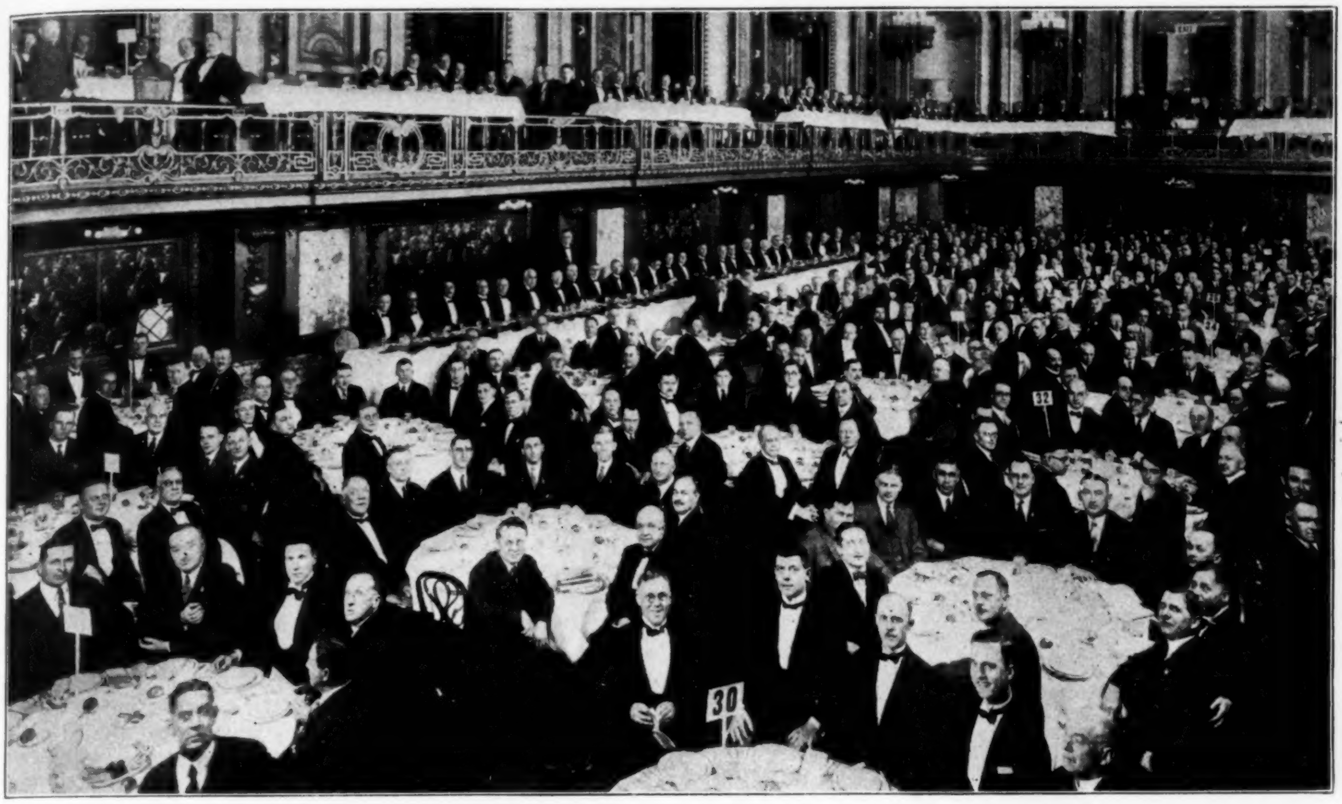
Turner, L. J., district motor car inspector, C., R. I. & P., Des Moines, Ia.
Tuthill, Job, asst. ch. engr., P. M., Detroit, Mich.
Van Antwerp, E. I., real estate inspector, G. T. W., Detroit, Mich.
Van Arsdalen, C. I., div. engr., I. C., Carbondale, Ill.
Vogel, John L., bridge engr., D., L. & W., Hoboken, N. J.
Wait, B. A., instrumentman, C., R. I. & P., Des Moines, Ia.
Walker, H. D., asst. engr., I. C., Chicago.
Wamsley, Cale, senior asst. engr., M. P., St. Louis, Mo.
Warden, R. E., asst. engr., M. P., Little Rock, Ark.
Wheelwright, Barton, special engineer, C. N., Toronto, Ont., Can.
White, R. C., asst. gen. mgr., Mo. Pac., St. Louis, Mo.
Whiting, C. L., supt. term., C., M. & St. P., Chicago.
Willahan, A. E., asst. engr., K. C. S., Kansas City, Mo.
Williams, C. C., head of department of civil engineering, University of Illinois, Urbana, Ill.
Williams, G. P., asst. engr. main. of way, L. I., Jamaica, N. Y.
Williams, S. D., Jr., div. engr., M. C., Bay City, Mich.
Williams, W. D., engr. main. of way, C. N., Van Wert, O.
Willis, R. W., dist. engr., C., B. & Q., Chicago.
Wilson, G. L., engr. maint. of way, Twin City Rapid Transit Company, Minneapolis, Minn.
Wright, G. I., office engineer, Chicago Terminal Improvements, I. C., Chicago.
Wynne, F. E., mgr. ry. equip., engr. dept., Westinghouse Electric Co., East Pittsburgh, Pa.
Young, R. C., ch. engr., L. S. & I and Mun., Marquette, Mich.

Guests

Argust, E. C., St. Louis Frog & Switch Co., St. Louis, Mo.
Austin, C. A. J., asst. engr., Wabash, Decatur, Ill.
Beatty, L. D., assistant roadmaster, Southern, Louisville, Ky.
Benson, V. N., asst. engr., E. J. & E., Joliet, Ill.
Blackman, William, Washington, D. C.
Boorom, A. W., maint. of way acct., B. & O., Dayton, O.
Bowers, Blair, asst. div. engr., Erie, Rochester, N. Y.
Bowlin, N. R., roadmaster, A., T. & S. F., Wellington, Kan.
Brightwill, C. E., supervisor, C. & O., Huntington, W. Va.
Buckley, G. E., engr. main. of way, Southern, Charlotte, N. C.
Cone, A. B., associate editor, Lumber World Review, Chicago.
Conley, J. E., pres., Conley Frog & Switch Co., Memphis, Tenn.
Davis, J. H., B. & O., Baltimore, Md.
Davis, J. J., asst. engr., E. J. & E., Joliet, Ill.
De Long, C. F., supervisor, B. & O., Ravennia, O.
Deorigo, J. T., dist. engr., N. P., St. Paul, Minn.
Douglas, L. H., master carpenter, B. & O., Akron, O.
Drew, James H., Ohio Brass Co., Mansfield, O.
Einstein, R. E., St. Louis Frog & Switch Co., St. Louis, Mo.
Ermentrout, G. J., insp. of motor cars, Reading, Reading, Pa.
Fergus, J. L., asst. div. engr., N. C. & St. L., Chattanooga, Tenn.
Ferguson, A. E., O'Fallon R. R. Supply Co., Chicago.
Foster, C. J., instm., C. B. & Q., Galesburg, Ill.
Gibson, H. R., div. engr., B. & O., Connellsville, Pa.
Gravelle, Raymond A., asst. engr., C. N., Detroit, Mich.
Gregwore, J. A., supt., Pennsylvania, Saginaw, Mich.
Gilbert, William, insp. water supply, C. & O., Huntington, W. Va.
Graham, F. N., asst. engr., D. M. & N., Duluth, Minn.
Groshell, W. R., A. T. & S. F., Fresno, Cal.
Hankammer, John, ch. clk. to supt., D. U., Dayton, O.
Harveson, C. B., div. engr., B. & O., Baltimore, Md.
Heitzman, W. L., chemist, M. P., Osawatomie, Kan.
Hohmann, J. J., Standard Underground Cable Co., Chicago.
Hughes, E. O., asst. val. engr., C. N., Van Wert, O.
Hynes, T. A., N. J. I. & I., South Bend, Ind.
Johnson, C. W., pres., G. A. Johnson & Son, Chicago.
Kennon, W. A., div. engr., M. P., St. Louis, Mo.
Kilheath, W. H., water service superintendent, B. & O., New Castle, Pa.
Kofmehl, W. H., Oxweld Railway Service Co., Elgin, Ill.
Malone, C. Q., master carpenter, B. & O., Akron, O.
Malone, J. I., supervisor, B. & O., Cleveland, O.
Martin, L. E., asst. engr., B. & O., Dayton, O.
Miller, R. H., General Electric Co., Kansas City, Mo.
Mohr, R. E., architect, Wabash, St. Louis, Mo.
Moorman, J. S., assistant trainmaster, L. H. & St. L.
Murch, Edward, master carpenter, Erie, Dunmore, Pa.
Park, E. G., vice-pres., New England Wood Preserving Co., Boston, Mass.
Parker, R. P., ch. engr., S. A. & A. P., Yoakum, Texas.
Pearson, R. C., div. engr., C. B. & Q., Alliance, Neb.
Pollok, F. A., asst. engr., St. L.-S. F.
Popjoy, C. F., superintendent water service, M. P., Atchison, Kan.
Rankin, D. M., asst. engr., A., T. & S. F., Topeka, Kan.
Roehl, G., supervisor track, G. T., Pontiac, Mich.
Rohr, E. J., supervisor bridge, building and track, C. & O., Cincinnati, O.
Schilling, J. H., asst. div. engr., Pennsylvania, Terre Haute, Ind.
Shatto, B. K., supervisor, B. & O., Massillon, Ohio.
Shieber, J. H., asst. bridge engr., M. P., St. Louis, Mo.
Smith, R. J., supv., Penna., Clayton, Del.
Steelsmith, P. W., A. T. & S. F., Topeka, Kan.
Stewart, L. W., supv., N. C. & St. L., Stevenson, Ala.
Suehrstedt, H. G., designer, I. C., Chicago.
Sutton, R. G., insp. water service, M. P., Little Rock, Ark.
Temple, S. A., asst. engr., B. & O., Cincinnati, O.
Vawter, R., supv., Louisa, Ky.
Wahl, A. W., supervisor, Erie, Callicoon, N. Y.
Weeks, H. E., salesman, Barrett Co., New York.
Wellman, R. L., assistant supervisor bridge and building, C. & O., Huntington, W. Va.
Wesley, J. B., chemist, M. P., Kansas City, Mo.
White, J. C., supv., Penna., Morristown, Pa.
Wooley, R. M., asst. engr., B. & O., Pittsburgh, Pa.



Landscaping as a Part in the Architectural Treatment of Bridge Work



The Annual Dinner in the Gold Room Last Night

A. R. E. A. Holds Greatest Dinner

Gold Room Crowded to Capacity. Frank H. Alfred and James C. Davis Speak on Railroad Problems

MORE than 750 persons crowded the Gold room to capacity last evening, on the occasion of the annual dinner of the American Railway Engineering Association. Every available seat on the main floor and in the balcony was taken and more than 100 were seated in ante-rooms. The dinner was the most successful ever given by the association. Keen interest was evidenced in every detail of the program. The advance announcement of the Arrangements committee that "something different would be presented" served to add to the interest of each feature of the program.

The railway atmosphere pervaded every feature of the dinner. Admission was by means of an annual pass on the AREA railway (the Ray Lines) which "entitled the holder to transportation privileges on everything except passenger trains," the seat location being indicated on a perforated coupon resembling a Pullman ticket. The menu and program were presented in the form of a time table in which the names of those present occupied the space normally given to the list of stations while the seating arrangement by tables resembled condensed schedules of through trains. Numerous photographs showed the advantages of Chicago as a seaport, a health resort and a scenic center in typical railway tourist bureau style. Numerous quips on current railway practices such as the "initial" movement so common in interdepartmental correspondence were also featured.

Music was furnished by The Chicago Ladies' Chorus of twenty young ladies, supplemented by Steindels' Orchestra, both of which were received with favor.

A train announcer appeared at intervals to call the departure of nationally known trains for various points. The California Limited of the Santa Fe was characterized as "being run in five sections for advertising purposes to carry those traveling on passes, revenue passengers taking the Floridian to Florida." Likewise the Broadway Limited was announced as "being run for those traveling on passes, revenue passengers being directed to the ten sections of the Twentieth Century Limited."

The invocation preceding the dinner was pronounced by the Rev. Joseph C. Hazen, D. D., pastor, the North Orange Baptist church, East Orange, N. J. George J. Ray, president of the association, called the assemblage to order and at the conclusion of the dinner, turned the program over to Douglas Malloch, humorist and lecturer, who presided as toastmaster and interjected a strain of rare humor throughout the evening. Mr. Malloch presented as the first speaker of the evening James C. Davis, director general of railroads and agent of the president, United States Railroad Administration, Washington, D. C., who spoke on "The Dawn of a New Day for Railroad Transportation." He was followed by Frank H. Alfred, president of the Pere Marquette, Detroit, Mich., who spoke on "The Engineer in the Ascendant." Both addresses were received with marked attention and favor.

The program was broadcasted by station KYW through the courtesy of station WHA, Madison, Wis., which operates on the same wave length and which re-

leased the air to KYW. As a result the addresses were heard by many beyond the convention hall.

The addresses of Mr. Davis and Mr. Alfred follow in abstract:

The Dawn of a New Day for Railroad Transportation

By James C. Davis

Director General of Railroads and Agent of the President, United States Railroad Administration

IN no country in the world has there been created a national plan of rail transportation comparable, in extent and efficiency, with the present system in the United States. When the great expanse of territory is considered, and the wonderful diversity of climate and products, the intimate trade relations maintained by rail transportation between the most

James C. Davis

distant parts of this country are a marvel of constructive performance, and an everlasting monument to the progressive spirit of America.

Transportation by rail is a most attractive and captivating subject. Men will frequently devote their time and service in this employment for less compensation and less chance of advancement than could be had in many occupations which do not offer the charm of "seeing the wheels go round."

The history of our railroad construction is most fascinating. It reads like a tale drawn from the imagination rather than a recital of actual accomplishment. The construction of this great plant can practically be said to have been commenced and brought to its present state of perfection within the memory of men now living.

In 1860, at the commencement of the Civil War, main line mileage aggregated but 30,000 miles. In 1870, at the commencement of the period of reconstruction following that war, the mileage was a little in excess of 52,000 miles. The peak of main line mileage was reached in the year ending December 31, 1917, just preceding Federal control, when it aggregated in excess of 253,000 miles of main line. Since that date more miles of main line have been abandoned than have been constructed.

The real growth and development of this industry marks the period from 1870 to 1917, some 47 years.

Restrictive Regulation

In 1876 the Supreme Court of the United States, in an epoch making decision, definitely announced the right of the government to control the destinies of public carriers, laying down the general rule that when property is dedicated to a public service it carries with it the right on the part of the government to exercise a reasonable control in the matter of rates and service, limited by the other rule, found in the Constitution, that owners of private property taken for a public service are entitled to just compensation for the use of such property.

This rate of compensation has been defined by Congress as one that "under honest, efficient, and economical management will yield a fair return on the aggregate value of the property held and used in the service of transportation."

Following this decision of the Supreme Court in 1876, there was a deluge of restrictive legislation enacted by Congress, as applied to interstate commerce, and by the Legislature of every individual state in the Union, as applied to intrastate commerce. This legislation, without exception, in effect decreased the operating income of the railroads, either by reductions in rates or increases in the cost of operation.

In the entire period from the date of this decision of the Supreme Court until the commencement of federal control, there was not a single line, in this flood of legislation, protecting the owners of the property in their right to a fair return on the value of such property as had been dedicated to a public service.

Operating economies, with which you are familiar, met for a time this rising tide in the cost of operation, but a crsis for the railroad interests was in sight when the exigencies of the World War compelled the taking over of their property, which was followed by twenty-six months of federal control and operation of the interstate carriers of this country.

Results of Government Operation

Concerning the care which the government gave the railroad properties operated during federal control, in the way of maintenance, there are many and conflicting opinions, but, as these claims have all been adjusted and paid, there is no purpose in entering upon a discussion of this subject. However, wholly aside from any questions of maintenance or compensation for the use of their property, the railroads did suffer a great economic damage by reason of federal control—a damage for which there was no provision by which they could be compensated—in that when the property was taken over it had net earnings for the year ending December 31, 1917, aggregating some $975,000,000, while for the year ending December 31, 1920, the same roads, so far as earnings for that particular year were concerned, were operated at a small deficit.

It is true that the guaranty given by the government for the first six months immediately following federal control prevented a financial collapse, but that guaranty was at the expense and cost of the government, and was made necessary by reason of insufficient rates existing at the end of the federal control period.

It is Emerson, I believe, who says that there are compensations in all things, and out of the travail and confusion resulting from the great war, and the government operation of the property of the railroads, the carriers have found some compensation not measured in the money they received from the government for the use of their property. May I refer, in a word, to some of these compensations?

Transportation Act—A Constructive Measure

It was the crisis in which the carriers found themselves that made the strong appeal to Congress to enact that very constructive and, in my judgment, progressive

piece of legislation known as the Transportation Act, a legislative measure which, while not generous, is at least just in the general principles which it announces. It puts the legislative stamp of approval upon the application of rules governing the public use of private property in transportation, which the Constitution lays down and which the courts have always protected and enforced.

While this act very substantially increased the powers of the Interstate Commerce Commission in the minute control which that body can exercise over the most intimate details of corporate organization, finances, and operation, it for the first time gives legislative recognition to the rights of the owners of the property, and attempts to codify in logical and legal fashion the rules by which the interstate carriers are governed and controlled through the Interstate Commerce Commission.

Mr. Chief Justice Taft, in construing and sustaining the recapture clause found in this law, said:

"The new act seeks affirmatively to build up a system of railways prepared to handle promptly all the interstate traffic of the country. It aims to give the owners of the railways an opportunity to earn enough to maintain their properties and equipment in such a state of efficiency that they can carry well this burden. To achieve this great purpose, it puts the railroad systems of the country more completely than ever under the fostering guardianship and control of the Commission which is to supervise their issue of securities, their car supply and distribution, their joint use of terminals, their construction of new lines, their abandonment of old lines, and by a proper division of joint rates, and by fixing adequate rates for interstate commerce, to secure a fair return upon the properties of the carriers engaged."

This puts the stamp of judicial approval upon the most constructive and progressive piece of railroad legislation ever enacted, and, as the years go by, it will be more and more recognized as the controlling contribution to a just solution of the great problem of national transportation.

Of course, this law increases in most drastic fashion the control which the government can exercise over the operation of all railroads. In effect, the carriers become not only the servants but slaves of the public, and this changed attitude is one which the public in any sort of spirit of fairness is bound to recognize. The only obligation on the part of the government, and this is an obligation that must not be minimized, is to see that the owners of the property receive the just compensation that the law provides for.

Perhaps, if there had been no federal operation of railroads, the controlling necessity for legislation of this character, containing a definite and just recognition of the rights of the owners of the property, would not have been so impressed upon Congress that it would have been enacted.

The carriers have received another compensation from federal control. Necessity is the mother of invention. March 1, 1920, at the end of federal control, when the carriers' property was returned to its respective owners, the men on whom rested the responsibility of successful operation and financial rehabilitation faced a task of no small dimensions. The railroads were then being operated at a loss. Their credit was at the lowest ebb in half a century. The menacing specter of failure, with consequent government ownership, overshadowed them.

This period of distress brought about a much greater co-ordination of the facilities at hand, and called for a higher standard of economic efficiency than had as yet been attained.

Progress of Last Five Years

The railroad management of this country has a right to feel some pride and satisfaction in the performance of the five years ending December 31, 1924. In the face of a most discouraging outlook, it took some confidence and courage to expend in excess of $3,000,000,000.00 in capital investment.

During this period the average operating ratio has been reduced from 94 per cent in 1920 to 76 per cent in 1924. The return on investment in 1920 was .09 of 1 per cent, and this return was made possible by reason of back mail pay. In 1923 this return was 4.83 per cent, and in 1924 4.36 per cent.

During the last two years the railroads carried the largest volume of freight traffic in the history of the country. The traffic was handled without serious complaint as to efficiency, and without shortage of freight car equipment or motive power. Weekly car loadings of more than one million cars occurred so frequently as to lose the charm of novelty. The confidence of the public in the ability of the railroads to carry on has been restored, and the spector of government ownership has in effect been banished, I hope never to return. This remarkable result has been accomplished with substantial reductions not only in the rates and charges which the public have been obliged to pay, but in the number of employes engaged in operation.

Another compensation, and perhaps the greatest of all, is the noticeably improved relations between the public and the carriers. If the American people can be brought to a realization that upon any issue they have a full, truthful, and frank knowledge of the actual facts, they can be relied upon to do substantial justice. Pitiless publicity on the details of income and outgo, and a realization that efficient service can only be had when fair compensation for such service is received, will surely result in Legislatures and Congress treating the vital question of transportation, so essential to any sort of national progress and prosperity, as an economic rather than a political problem.

The recent action of the House of Representatives on the Pullman surcharge, a most unpopular exaction but at this time an essential one, reflected a spirit of fairness that is most encouraging, and prevented what might have been a most deplorable precedent in an effort by direct legislation to control rates.

The railroad executives and managers have learned, perhaps in the bitter school of experience, that in the advanced progress of government control they have become, in the operation of their properties, the servants and not the masters of the public, and it is up to them to give a just account to the people, through the Interstate Commerce Commission, of their respective stewardships.

As a matter of fact, the carriers must now stand or fall with the government. Congress, through the Commission, having taken over the authority of detailed control in all vital particulars, cannot escape the responsibility of providing a fair return upon the property devoted to a public use, based upon an honest, efficient, and economical operation, and the burden of proof will always be upon the railroad executives to establish that they have done their part.

In this struggle for a compensation that will bring even a modest return to the owners of the property, efficient operation is and always must be the controlling factor which will achieve success. Without this, there will be failure.

Mr. Coolidge, in his recent inaugural address, in speaking of patriotism, said:

"We have been and we propose to be more and more American."

The railroads of the country could well adopt this thought of the president, so admirably expressed, and apply some of their responsibilities, by saying:

"We are now giving and we propose to continue to give better and better operating service."

How to Win Railroad Battle

With a high standard of operating service, and with full, fair, and absolutely truthful information for the public as to all details of corporate management, the battle for private ownership, with a reasonable and just public control, is won.

Referring again to what appeals to me as a most wonderful document, the recent inaugural address of President Coolidge, which I believe is the most hopeful and sustaining declaration of the aims and purposes of the government that has recently been presented to the American people, this address contains an enunciation of those principles essential to the continued growth of our republican and representative form of government. It means that for the next four years the provisions of the Constitution, as construed and enforced by the courts, will stand. It means, so far as applicable to present and modern conditions, a return to those sturdy principles which actuated the fathers when our government was created. It means that personal and individual efficiency is the cure for the aftermath of war, rather than legislative nostrums, which never cure and rarely palliate.

In reference to railroads, the president said:

"Likewise, the policy of public ownership of railroads and certain electric utilities met with unmistakable defeat. The people declared that they wanted their rights to have not a political but a judicial determination, and their independence and freedom continued and supported by having the ownership and control of their property, not in the government, but in their own hands."

The carriers now have their opportunity. "By their fruits ye shall know them." It would now seem to be within their grasp to put their property upon a fairly remunerative basis. Efficient service can only be furnished when there is sufficient income to bring a fair return to the owners of the property.

Full and free publicity of actual facts must necessarily be the basis of future confidence, and if the railroad interests of this country in the future can give as good service as they have given in the last two years, and, in connection with that service, take the public generously into their confidence, so that there can be no mystery, no concealment, and no confusion as to cost of operation, much progress will be made in permanently settling our national transportation problem upon a just basis, and the people of this country will continue to receive what they are now getting, and what they have always been entitled to—the most efficient transportation in the world, at the cheapest and most reasonable rates.

The Engineer in the Ascendant

By **Frank H. Alfred**

President, Pere Marquette, Detroit, Mich.

I have chosen for my subject, "The Engineer in the Ascendant." Should too frequent use of the personal pronoun be made, I beg of you not to accuse me of egotism. I have heard egotism defined as being "nature's anesthetic to relieve the pain of inferiority."

By tradition I should have been a lawyer, and had I been a well-behaved youth while in high school, I probably would have been a lawyer. In my senior year, about a month before graduation, I was excused from appearance at the school by the principal. This recess occurred just when sewers were being built in the small town in which I lived, and it was my delight to assist the none-too-thorough surveyor in running lines and giving levels in the work. I was permitted

Frank H. Alfred

to return to school, and graduated with my class. That taste, however, of the rudiments of technical work was the sealing of my fate.

A very large mileage of railroad was constructed immediately following the Civil War and extending into the early eighties. Engineering departments for handling maintenance work were practically unknown. The engineer's work was confined almost entirely to construction. The upkeep of the property was left to the untrained mind. Consequently, the track centers were lost and elevation stakes disregarded to such an extent that it became necessary, with progressive managements, to inaugurate the Department of Maintenance of Way under the supervision of a technical man.

How well I recall when the practice first came into favor of re-centering track, and, before the spiralling of the ends of curves had come into vogue; with what difficulty we were able to induce a section foreman, and even the roadmaster, to re-line track to the tack point centers, which were so accurately given. Many were the times we were told the track, after being relined to the accurate centers, rode almost as good as it did when lined by the foreman's eye. I recall in the early nineties when with the Norfolk & Western, as a young man in charge of field engineering, at the time the extension of that line was being made into Columbus, Ohio, the delight I experienced when the foreman, who had been sent to Columbus from down the road because he was the most expert trackman on the system, had to admit to me he was unable to put in the slip or puzzle switches with movable frogs, which were to be installed in connection with that project. I, an engineer, was obliged to take over and actually perform the work of the foreman on this particular job. We have all gone through such experiences and it has had a wholesome effect upon the railroad forces all along the line, no doubt.

Value of Engineering Education

I have been asked a great many times, by young men in high schools and colleges, for advice or suggestions as to the profession they should enter, I have never hesitated to advise every young man, either of a mechanical turn of mind or with a genius for constructive work, by all means to equip himself

as an engineer, whether it be mechanical, civil, electrical, hydraulic, or mining; that it mattered not to what business he turned his attention later in life, whether he went into another profession, law or medicine, or whether he engaged in industry, the training he received as an engineer would always stand him in good stead and enable him to work out problems which otherwise might mean his Waterloo.

I have had opportunity in my career to meet with men in every profession and I can say without hesitancy or doubt that the engineer represents one of the highest types of man. His conduct with facts in all of his work has a tendency to make him reliable and the factors of safety with which he fortifies his work, make his monuments likewise reliable. The engineer with a reputation to sustain never takes a chance, but bases all of his calculations on known factors.

There probably have been too many lawyers in the United States in proportion to the population, and probably too many doctors. I make this statement advisedly, as the statistics during the past decade, that is, the period from 1910 to 1920, show that the number of physicians per 100,000 population decreased from 164 to 142, or 13.4 per cent; lawyers decreased from 125 to 116, or 7.2 per cent; clergymen decreased from 128 to 120, or 6 per cent; while the members of the various branches of technical engineering increased from 98 to 128, or 52 per cent. For the first time in the history of the profession, the engineers in this country have risen in number above the clergymen and lawyers, and it is reasonable to believe that soon they will overtake the physicians. This reflects not only the tremendous growth of American industry, but also the penetration of industry by science.

"We have been and we propose to be more and more American."

The engineer is largely engaged in projects of a labor-saving nature. The ratio of cost of labor on a railroad to the total expense is somewhere in the neighborhood of 55 per cent, depending to some extent upon the physical condition of the property, and density of traffic. Because of these figures, let us not conclude that labor represents but 55 per cent of the cost of transportation, or of any other business. We must not forget that the other 45 per cent, usually considered as representing material that goes to make up the expenses on a railroad, consists of fuel to the extent of from 12 to 14 per cent, materials and supplies of a little larger per cent, about 15 per cent, etc., in the production of which labor is the principal factor. In fact, labor represents more than 90 per cent of the cost of products in general use throughout the country in all business and in the home.

The conservative element of this country is sometimes considered as an obstruction to development. Too often the greatest obstruction has been labor itself, organized and unorganized. That has been one of the great fights of the country for the past quarter of a century. Labor has in the past vigorously opposed the adoption of tools and appliances that have for an end the taking of drudgery out of labor. There are proportionately more skilled workers in the United States today than at any previous time during the last quarter century. It is true there has been a falling off in mechanics in wood working crafts, wheelwrights, cabinet makers, coopers and carpenters, but it is likewise true that during the same period there has been a tremendous increase, proportionately, in skilled men in the building trades,—plumbers have increased many times, machinists have doubled, electricians have multiplied. The woodworkers have simply shifted to other lines of craftmanship in accordance with a changing phase of industry.

How Labor Saving Helps Labor

Modern machines have not degraded labor, but they have been the means of elevating laborers to mechanics. It is only recently that labor has come to realize that the improvements in machinery, tools, and working appliances of all kinds have done so much or more toward advancing its standard of living then has the reduction in working hours.

It may be said there is no such thing as over-production, as a whole. There may at times be under-consumption. There may be too much of a particular thing in a particular place and at a particular time, but the situation soon adjusts itself. Temporarily, there may be more of anything than is needed in certain localities, but it will soon be properly distributed and absorbed as needed. The wants and needs of the people are constantly becoming greater. The laboring man has more leisure, and thus his wants are more. Man is now performing his labors in less than nine hours per day—approaching the eight hours recognized as being the standard work-day. Civilization is the result of the higher development of needs and requirements. The whole scheme of society is for the enlightenment, pleasure and comfort of man. The more highly these developments are carried, the more numerous are the needs. That is why transportation in the United States is more intense than in any other country.

I recently had occasion to compare the situation in Mexico with that of Canada. I made a short trip to Mexico City and Vera Cruz. We entered by the Laredo gateway and rode over the National Railways of Mexico from Mexico City to Vera Cruz and return. The condition of the railroads over which I traveled was a very pleasant surprise to me. All of the National Railway between Laredo and the Capitol, 803 miles, is land with heavy rail in excellent condition, and the larger portion of the line is ballasted with broken store, the cross sections of which are most generous both as to the amount under and beyond the ends of the ties. All of the motive power that came to my notice was in excellent condition. The locomotive engineers encountered were most skillful in the handling of trains, and particularly in the use of air. The train crews were likewise alert and most dexterous in the performance of their particular duties.

In Canada there are in the neighborhood of 40,000 miles of steam railroads, with a population in the Dominion of 9,000,000 people. In Mexico the total steam roads approximate 10,000 miles, or one-quarter the mileage of Canada, with a population twice as dense as Canada. Mexico is a good example to show conslusively that density of population per mile of railroad does not prove, by any means, that the traffic of the railroad is heavy. Mexico is not a consuming nation. The individual needs are small; the peons' wants are few. Consequently, there is less to be transported.

This brings us to the great problem, namely, the conservation of time. It is desirable that man should be able to make his living by working say eight hours per day at his calling, but it has always been more important that his leisure time should be devoted to the improvement of his mind and body. Things never stand still,—they are either improving or going backward. Man, with idle time on his hands, will either improve his condition and that of society, of which he is a part, or he will degenerate.

What are we here for? As I see it, we are living in this world for the cultivation of our powers, spiritual, mental and physical, and for progress ever onward, never remaining stationary.

The engineer is responsible, more than any other profession or class, for lightening the burden. He is responsible for the wonderful progress that is being made in the fields of manufacture, industry and transportation, as well as in aerial navigation and in radio and other electrical developments.

After having turned our attention to the great physical and intangible powers of nature, we return to the practical things in the life of the technical man. Let us consider his responsibilities, first in the field in which he is particularly interested, and then in the technical field at large, and along with both, his obligations as a citizen.

First, as engineers, particularly civil engineers in the employ of the great transportation companies: Are we, as the chief officers of the Engineering and Maintenance of Way Departments, confining ourselves so closely to routine work that we have lost sight of the great possibilities for accomplishment in the engineering field? The fact that a man has been educated as an engineer does not carry with it an obligation to continue as a professional engineer. The majority of the inventors of mechanical appliances are technical men. Railroad engineering, like everything else, has developed more rapidly during the last quarter of a century than at any previous time. During the last decade, railroad engineering has taken on refinements that were previously not given much consideration. Higher standards are being observed in developing the proper roadbed and drainage, in the use of larger ties, and in the treatment of all wood materials used. Roads that can afford it are having the ties dapped for plates and bored for spikes, and canted plates are very much in evidence. There is, however, a good deal of discussion as to whether or not the principle on which their use is based is sound.

Need for Permanent Roadbed

I mention these physical matters in connection with the track for one particular reason,—that I want to bring the mind of the engineer face to face with our present condition. Approximately 25 per cent of all the money expended on maintenance of way and structure is under the caption "I. C. C. Classification 220-Track Laying and Surfacing," and I venture that of that 25 per cent, one-half is spent in surfacing and lining track: Every dollar spent in picking up a low joint that could have been kept from becoming low, is an economic waste. There is a wonderful field for the development of a permanent roadbed and I cannot understand why it is not being developed more rapidly. You will all recall a few years ago, when concrete roads were recommended as the proper form of construction for highways, that many of us felt the benefits would not be sufficient to warrant the expenditures, and that gravel roads could be built sufficiently good to take care of the highway traffic and the maximum speed that would be required, etc. The road construction program started off, to a considerable extent, by surfacing with gravel, using concrete only for the more important roads where the traffic was dense. It soon developed that the gravel roads could not be maintained at a reasonable cost under high speed traffic. All of the first class highways everywhere are now being built with either concrete or some other permanent construction. The Appian Way, which was built 312 years before Christ, extending from Rome for 350 miles to the southeast, was built at a width of from 14 to 18 feet and the construction was largely of stone. At the present time there are still evidences of this roadway although it is considerably over 2,000 years old.

Why does the railroad engineer develop a permanent roadbed on railroads where grade reductions and relocations have been made to meet the demands of the day? There is no doubt but that roadbeds can be made of a permanent nature, and yet with a flexibility that will permit of proper repairs, at a cost per mile that would not much exceed, if any, the cost of building the modern highway. I am confident that money invested in permanent roadbeds will effect a saving in labor, from the start, that will more than take care of interest and depreciation on the investment. I am afraid that the railroad engineer is not fully aroused to the responsibility which he carries along the line of advancement, and I believe it is high time that an active rivalry should be instituted among the railroad engineers along the line of a permanent roadbed. In addition to the saving a permanent roadbed will effect in the maintenance department, there will be as great, or even greater saving in the mechanical department through the reduction in the cost of maintenance or locomotives and cars that will result from the operation over a smooth and even surface. This will also enable trains to be handled at higher speed,—particularly freight trains, and will result in far greater comfort to the traveling public.

To develop a successful permanent roadbed would probably require a good deal of experimenting. If a dozen separate designs were tried independently it is not likely that any one would be so successful as to require no modification. Improvements of this kind do not come about in this way. They are the result of experiment and adaptation to meet the requirements found to exist, which often cannot be known in advance of actual trial. In general, change after change is found to be necessary before a satisfactory design is reached. This requires time and money, and there is the rub. Most of us do not control the purse strings of the organizations with which we are connected, and those who do control them are prone to let the other fellow do the experimenting, with the result that it is not done.

More Railway Research Necessary

I believe this attitude accounts in large measure for the extreme conservatism of railroads in adopting new ideas. With a few exceptions, they do no experimenting except along very modest and inexpensive lines. The result is that improvements in motive power, equipment, tools and track accessories are developed by the manufacturers, who, after much persuasion, prevail upon some road to give them a trial, under the manufacturer's guarantee and at his expense. If successful, in the course of a few years some other road will be convinced; and then, one by one, the roads will follow in line until at length the appliance becomes standard equipment. Any equipment man can tell you his troubles, and will if you give him half a chance.

I hold that this is not the right procedure; but that improved methods and appliances should be initiated and developed by the roads themselves. What a contrast is offered by the methods of our leading industries who spend millions every year in research and experiment? What would be the present status of the automotive industry, the oil industry, the great electrical companies, if they had pursued the policy followed by the railroads? The answer is evident. There would have been no such industries, for they were founded on research and experiment and through research and experiment they have reached their present status, and without it they would cease to exist. Other public utilities, such as electric railways and telephone companies, excel the steam roads in this respect; and even the states build costly experimental test sections of highways.

Surely the operations of a great railroad are of enough

importance to justify a reasonable amount of experiment and research, and any of the larger systems could well afford to have a department for this purpose. However, on account of the general tendency to let the other fellow try it first, I am heartily in favor of establishing a joint bureau of research, supported by all the railroads of the country, and as the first major subject of experiment I would propose the development of a design for a permanent roadbed.

Railroads were actually driven to use the automatic coupler through an Act of Congress. At this time, automatic train control is being reluctantly installed under orders from the Interstate Commerce Commission.

The standing of railroads with the public would be improved if we would think well ahead of the needs of the day, and be ready to apply improvements as fast as the community requires. Experience of other utilities has proven that the public is willing to pay liberally for improved service.

And we who, although we may not control the purse strings, yet, direct the expenditures when (and if) allowed, are we not in a large measure responsible for our lack of progress in this respect? Have we been really open-minded in regard to innovations, and if convinced of their value have we urged their adoption as we should? Or have we been content to let well enough alone, our consciences easy after having gently suggested to the management that such and such looks like a good thing and might be worth trying? Let us not forget that we are the fellows who know, and as such, are, to a large extent, responsible, and that our recommendations will carry weight in proportion to the urgency with which they are presented.

St. Lawrence Waterway Problem for Engineer

Second, the obligation of the engineer in regard to engineering problems at large, in which he is not directly concerned. I refer to the national problems that are constantly before us. We are all interested in progress. There is a disposition on the part of some of our politicians, supported by a certain part of the press, to exploit the field of possibilities even beyond the capacity of the public to pay for and absorb such developments, and there is also a disposition to class men who do not take up readily with new ideas, as obstructionists. There is no one who can help more to mould public opinion along proper channels than the engineer. We have before us at this particular time, a national problem which is being studied by a committee, of which the Secretary of Commerce, I believe, is Chairman, and that is the Deep-Sea Cut from the St. Lawrence through the Great Lakes. I have watched the growth of the propaganda that has been circulated in connection with this project during the last couple of years and have been astounded to note the willingness, and, in fact, the eagerness of the public to take on such a tremendous obligation without any assurance of the benefits to be derived therefrom. Navigation between the Great Lakes and the Ocean, via the St. Lawrence, has been a fact for many years, the connection being made through the Welland locks and canal. Studies have also been made over a period of years as to the economic dimensions for a waterway from the Great Lakes to the Atlantic. I think we can all agree upon the basis that an economic waterway would be one that would take care of the traffic, existing and possible, over a reasonable period of time. Without going into the pros and cons of such a development, whether for navigation alone, or for navigation and power development, and without expressing myself either for or against the project, I do claim that this is one of the problems that every railroad engineer, particularly in the Great Lakes District, should interest himself in. He should familiarize himself with the information on the matter, both from an engineering and business standpoint.

It is always more interesting to be engaged in a great problem of development and construction than to handle the hum-drum of the maintenance of a property, and the construction engineer is always more susceptible to the allurement of, and is more apt to be carried off his foot with the possibility of some great development, while the engineer who has given his lift to the maintenance and upkeep of projects, knows that the future upkeep of the property is dependent entirely upon its earning possibilities. Like most engineers, there are some things he much prefers to do than others, but we must all do the things that are required of us.

The successes in the United States have been built, largely, on the individual. Has the time arrived when individual effort can no longer accomplish what it has accomplished in the past? I confine the query to our own country for the reason that the United States, although one of the youngest countries, is the furthest advanced of all the countries of the world. If I mistake not, there is to be a complete revolution in the methods of the conduct of business. What has heretofore been accomplished by individual initiative and action, can now only be successfully done through the mass or group formation. It is becoming a work of the machine. This is true in both business and politics. Men are not less brilliant now than in former days, but there are so many more brilliant stars in the constellation that the opportunity for the individual to shine beyond his fellow-man is more difficult. Where in former times many of you acted on your own initiative, today when any matter of importance comes up in connection with your work, you consult the manual that this Association has been so long in bringing to the high standard of perfection, and which is now recognized as the authoritative document on everything that pertains to the physical properties of a railroad.

Third (as a citizen). The new order calls for specialization, but we should not allow ourselves to become lop-sided. It is a fine thing to be a specialist in business, but in matters pertaining to life it is a finer thing to be useful as citizens in the uplift of the community in which we live. Every good citizen must give freely of his time to the public business for the benefit of society as a whole.

Regarding College Education

A diploma from the university or college is a very great asset to any young man, and should enable him to start farther up the ladder and climb much faster than the youth who has not been able to acquire these coveted advantages. This brings up the much mooted question—Is a college education of benefit to the man who does not intend to engage in a professional career? Of course all cannot engage in a professional career (literally speaking) for of the 25,000,000 producers in this country, more than eighty per cent, or 20,000,000 are laborers. Notwithstanding the appeals of the presidents of our universities for university training for all, I appeal to the good judgment of the business men and skilled workmen as to the logic of the promise as advocated.

The average age of the university graduate is, say 24 years, which is not unreasonable for a man enter-

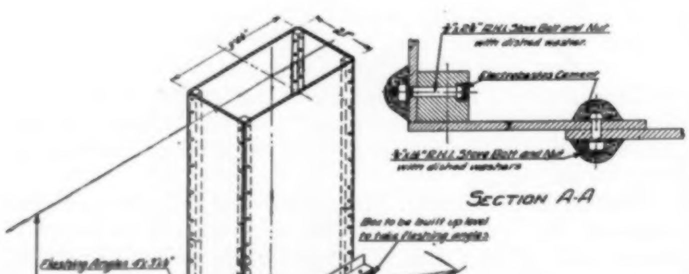
ing law, medicine, engineering or other professions. The men who enter professional life must, of course, have clients. Therefore, some must engage in other pursuits in order to support the professional men, else the whole structure will fall.

From the statistics given earlier in my talk, it will be noted that the professional men form a very small proportion of the total population. As to the others, it is a debatable question whether a college education is not a handicap, rather than an advantage, as against the practical experience gained by a young man who puts the college period into the business or trade which he is to follow the rest of his life.

I have a high regard for the college man, but a much higher regard for education from whatever source derived. It seems to me that the important thing is—that a man be an artist in his calling in life; that his mind be attuned to his work; that the books show his account with his employer to be on the credit side of the ledger. If a man possesses these qualifications, then he is possessed of a diploma admitting him to the practice of his calling in the courts of life, be that calling a profession, a business, a trade, or the most humble kind of manual labor.

Improvements in Transite Smoke Jacks

THE Johns-Manville Company, New York City, is introducing three new types of transite smoke jacks which constitute a radical change from the types of smoke jacks heretofore built by this company, in the practical elimination of molded parts. To illustrate these new jacks, a diagram is presented of one of the models, type AW. In this jack a stack is provided which



The Plan of the Transite Smoke Jack Class-AW

has a rectangular section, as distinguished from the eliptical section of the earlier jack. It also has a hood of rectangular sections, while all sides of both the hood and stack are built up of flat sections of asbestos wood.

The only molded sections in this jack occur at the intersection of the hood with the stack, whereas in the former types of transite jacks practically all of the pieces were molded. This change in the design has not only simplified the manufacture of the jack in that all pieces can be made from standard flat stock, but it promotes less breakage in shipment, and easier erection. Since the flat pieces can be stacked both prior to shipment and after shipment, the advantage of the new form of construction also dispenses with the need of providing large areas in which to shelter the materials prior to erection and prevent warping.

A further advantage of using the flat stock is that all flat pieces can be drilled and that all similar pieces of the jacks are interchangeable, thus, if one of the pieces should be broken during erection a similar piece can be ordered from the factory with the assurance that when it arrives it can be put in place immediately with a minimum of trouble. In building the jacks the flat stock is reinforced at all four intersecting edges of the stack and hood by two inch strips, to which the asbestos board is attached by means of round headed stove bolts with dish washers, special cement being applied to protect the metal from corrosion. Stiffener angles are also placed on the sides of the hood to provide additional reinforcing for these larger areas. The three models of jacks differ from each other only in the distance from the bottom of the hood to the stack. They are alike in other respects, the stack providing a 21-in. by 3-ft. 6½-in. opening, while the opening in the bottom of the hood is 3 ft. 6 in. wide and 10 ft. long. The new jacks thus have a much larger stack area than the previous styles. They have been designed throughout to meet the requirements of locomotives having the largest grate areas now built.

Improved Electro-Mechanical Interlocking Machine

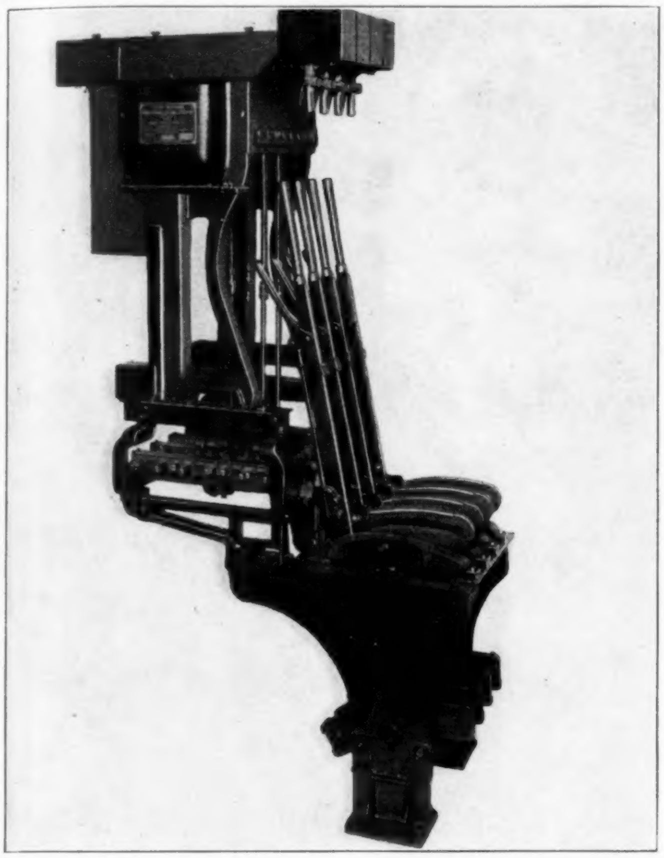
THE Style S-8 electro-mechanical interlocking machine as now constructed by the Union Switch & Signal Company includes a number of improvements in the design of the electric units and their supporting frame which add to the flexibility, contact and wire capacity, accessibility, and appearance in general. Horizontal or vertical rollers may be added, removed or exchanged at any time. The electric lever supporting frames are made in four and eight-lever sections which may be mounted over the locking bed of a new or an existing S. & F. machine without reference to the S. & F. sections. Additional units and supports may also be applied later as desired.

A modification in the design of the jaw type electric lever driver, doubles the number of locking bars which are possible of connection without any interference between the connecting rods and brackets. Provision is made for one, two, or three indicator lights per unit if desired. Cast-iron front and back plates form a part of the supporting frame in place of the channel sections formerly used.

Greater capacity for wires is available due not only to more and larger openings in the electric units but also to the supporting legs having larger wire chases. The vertical chases provided in the legs have sheet steel covers, allowing access to wires, and outside conduit connections are made at the base of the legs by means of right or left hand "T" or straight conduit outlets.

The contact capacity of electric levers makes it possible to secure practically all of the advantages of electric locking obtained with power interlockings. Horizontal rollers provide 12 contacts, vertical rollers, 24 contacts and when necessary an extension to the vertical rollers

supplies 16 additional contacts. Individual covers are furnished for each electric lever unit. A wire chase, having a suitable cover, is cast in the back of the vertical units and provision is made for direct cross wiring be-

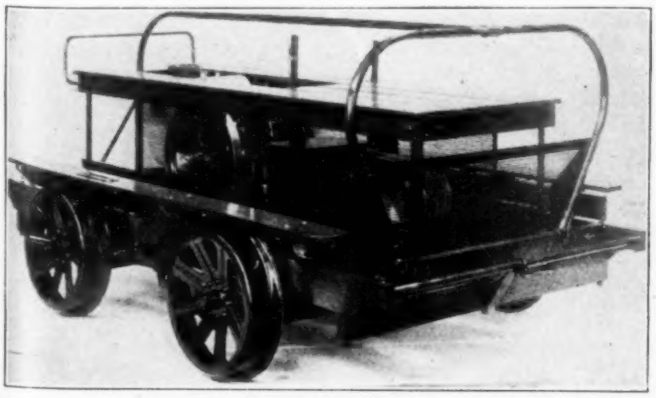


New Design Electro-Mechanical Interlocking Machine

tween such vertical units. Experience indicates that Style S-8 electric lever units added to existing mechanical machines, allow for considerable expansion in the operating capacity of the interlocking without requiring additional tower space.

Improved Fairmont Cars Carry New Engine

SINCE the development about a year ago by the Fairmont Railway Motors, Inc., Fairmont, Minn., of its MT-2 motor car, which invited attention particularly for its two-speed transmission and interchangeability of

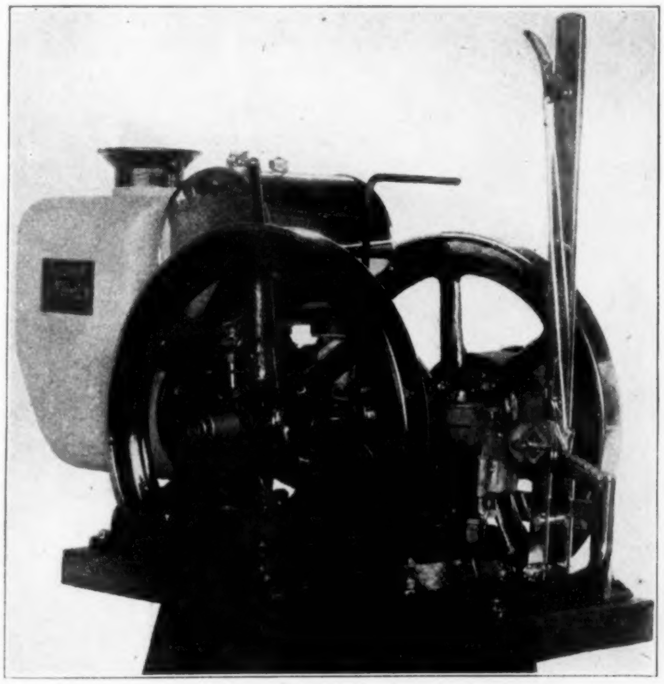


The Transmission End of the New Car

use for extra gang or ordinary section forces, this company has been devoting study to the perfecting of the equipment with the result that it is now introducing two new cars called the Advanced Series motor cars A-2 and AT-2, the first being a section car while the latter is a gang car.

The two cars are identical except that the gang car has a two-speed transmission for use when it is desired to carry unusually heavy loads. The frame of the new cars has a diagonal girder type of construction which employs a steel backbone for reinforcement. The distinguishing feature of this frame is the low center of gravity it gives to the car, which is accomplished by the underslung character of the cross girders, which brings the lower edge of the side sills of the car and the deck floor flush with the top of the car axles instead of several inches above it.

The principal change in the new cars is in the employment of a new engine. The new ball bearing Fairmont engine, Class 2-B, as it is called, is a six horsepower unit of the free running, reversible type which differs from its predecessor in several important details, prominent among which are the oversize bearings used on the crank shaft and the enlarged crank pin with which it is claimed the engine will operate continuously for several years without adjustment. Like the preceding models this engine operates on a sliding base, the purpose of which is to vary the tension on a drive belt which transmits the power to the car, but the sliding base guides for the new



The New Engine Is an Attractive Unit

engine have been increased to three times the former area to reduce wear at this point and, in addition a spring device has been installed which maintains the tension of the sliding base automatically, thus dispensing with manual adjustments. Vibration is said to be absorbed by a self-shock absorbing type of sliding base lever links.

Among other improvements incorporated in the new engine are an automatic timer with adjustable points similar to those used on automobile equipment, also the use of two fly wheels which are alike for the purpose of interchangeability. The engine also carries an aluminum water jacket which is guaranteed against freezing and provides unusually large capacity. This engine has been designed especially for the two new cars, but, like its predecessors, it has been also developed with a view to its

use on other cars as where railroads are changing hand cars into motor cars.

An additional improvement in the cars is the use of an endless cord belt from the engine to the counter shaft, this shaft, as before, being mounted above the deck of the car and actuating a roller chain which engages the drive axle of the car. A two-speed transmission for the gang car consists simply of adding to the mechanism a two-speed gear, the effect of which is to allow an increase in the number of men handled to 60, the capacity of this car without the two-speed transmission being 12 men on the car and 30 on the trailer. With the additional features of four adjustable wheel brakes and heavier axles the cars are made the object of attractive claims by the

Electric Speed Indicator for Locomotives

THE introduction of automatic train control has resulted in the development of a system by the Union Switch & Signal Company in which the speed of a train is limited to any predetermined value depending upon the track conditions ahead. This system enforces the operation of trains in accordance with signal indications and track conditions and functions either to stop the train or to reduce the speed by an application of the brakes when the engineman fails to comply with the signal indications. An electric speed indicator has now been developed by the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., for the purpose of providing the engineman with a continuously visible indicator on the locomotive from which he can at all times determine the actual speed at which the train is running. This indicator is used in connection with the U. S. & S. Co.'s equipment.

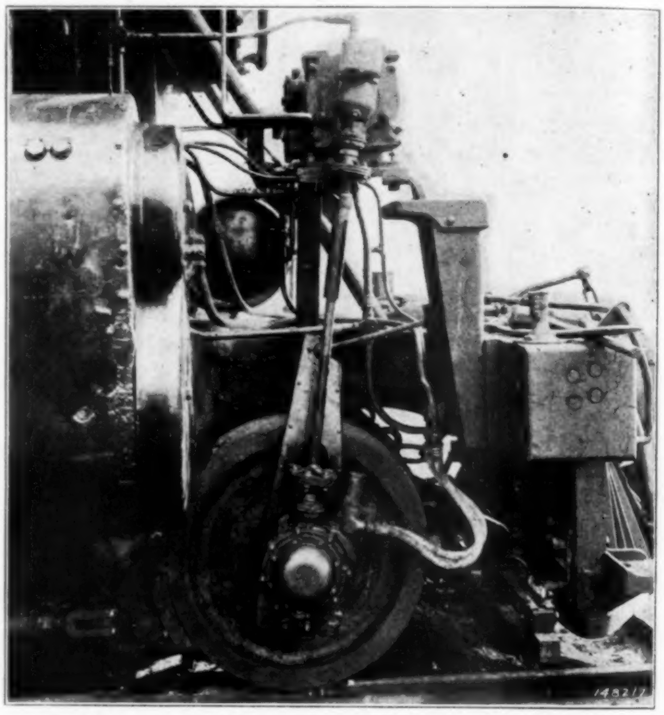

Magneto Generator

The speed indicator itself consists of a direct-current magneto and a voltmeter. The magneto has been especially designed for this service, having a very low output and a well aged magnetic field structure. The brushes are made of a gold alloy and the commutator is made of 14-karat gold bars in order to guard against corrosion and resistance changes.

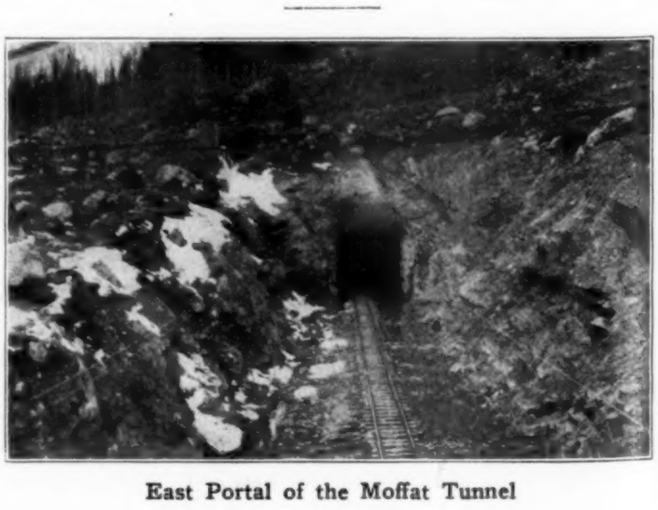
Speed Indicator Mounted in Cab

The indicating instrument is a Westinghouse D'Arsonval voltmeter calibrated to read miles per hour. This instrument is located in a conspicuous place in the locomotive cab, making it convenient for the engineman to keep a close check upon the train speed and his running schedule. Because paper dials are subjected to warping and discoloration from atmospheric conditions, lithographed metal dials are used. This instrument is mounted in a special bronze case, thus affording water and steam-proof features.

The electric speed indicator magneto is mounted on the top of the governor shaft housing and is driven from an extension on the governor shaft itself. The governor is of the fly-ball type and can be adjusted to operate at any running speed desired. The installation or removal of the magneto is simple. A small hand-hole cover, originally fastened to the gear housing, is removed and the magneto then inserted in its place. The magneto serves not only as a part of the speed indicator but also is the hand-hole cover plate and may be removed readily for inspection and oiling of the governor gear mechanism by removing two bolts.


The Magneto Is Mounted on Governor Shaft Housing

The top of the governor shaft is equipped with a small pin which fits into a milled slot in the bottom of the magneto shaft, thus giving a self-aligning, direct-connected drive for the speed indicator magneto.


East Portal of the Moffat Tunnel